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DATE: 4 December 1996

FROM: Burton G. Hurdle (Code 7103)

SUBJECT: REVIEW OF REF. (a) FOR DECLASSIFICATION

TO: Code 1221.1

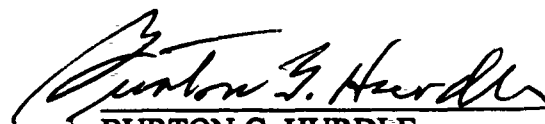
VIA: Code 7100

REF: (a) NRL Confidential Report #5599 by A. McClinton et al, 14 Feb 1961

1. Reference (a) is a description of the high-powered source for driving the ARTEMIS acoustic array. It includes the design characteristics, photographs of the various components, including the diesel generator, the acoustic array, and the various handling components. These components are shown installed in the Mission Capistrano, a modified type T-2 U.S. Navy tanker. The ARTEMIS program was an experimental research program at low frequencies (400 Hz) to detect and track submarines. The program was not fully completed and never reached operational utilization.

2. The technology and equipment of reference (a) have long been superseded. The current value of this report is historical.

3. Based on the above, it is recommended that reference (a) be declassified and released with no restrictions.



BURTON G. HURDLE

Acoustics Division

CONCUR:



12/7/96

EDWARD R. FRANCHI

Date

Superintendent

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AD- 322487

SECURITY REMARKING REQUIREMENTS

DOD 5200.1-R, DEC 79

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NRL Report 5599

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PROJECT ARTEMIS
HIGH POWER ACOUSTIC SOURCE
[UNCLASSIFIED TITLE]

A. T. McClinton, R. H. Ferris, and J. Cybulski

Electrical Applications Branch
Sound Division

and

A. M. Barton

Engineering, Design, and Drafting Branch
Engineering Services Division

February 14, 1961

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Classification of full document

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This document has been reviewed in a review with a rating of 5510.27.
Paragraph 6. The classification and the document are correct.

Date MAR 31 1961

By direction

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NRL Report 5599

PROJECT ARTEMIS

HIGH POWER ACOUSTIC SOURCE

[UNCLASSIFIED TITLE]

**DESCRIPTION OF THE FACILITY AS INSTALLED
ON THE USNS MISSION CAPISTRANO (T-AG 162)**

[CONFIDENTIAL TITLE]

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Engineering Services Division

February 14, 1961



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ABSTRACT
[Confidential]

This report describes the installation of a high power acoustic source on the modified T-2 type U.S. Navy tanker. Although the work was not completed at the time of the preparation of this material, photographs of the ship installation as well as the ship modification are included to show location of equipment and the extent of the modifications. The resulting facility has been designed to provide a mobile high power source of acoustic energy in the frequency range between 350 and 450 cycles per second at an acoustic power of 1000 kilowatts. Ship facilities will permit lowering the transducer to a depth of 1200 feet. In addition, provisions have also been made which will permit fixing the transducer to the ocean bottom at a later date.

PROBLEM STATUS

This is an interim report. Work on this project is continuing.

AUTHORIZATION

ONR NR 287 002 (Special)
NRL Problem Number 55S02-11

Manuscript submitted January 10, 1961.

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INTRODUCTION

The high power acoustic source for Project ARTEMIS, consisting of the source of electric power, amplifier, transducer array, cable handling machinery, array winches and other miscellaneous equipment, is installed on the USNS MISSION CAPISTRANO (T-AG 162). The acoustic source complete with its transducer, which can be suspended from this ship, are designed to provide an acoustic capability as outlined in Table I.

TABLE I
PROJECT ARTEMIS
HIGH POWER ACOUSTIC SOURCE

Frequency	400 cps
Power	1000 kilowatts acoustic
Beam pattern	
Vertical	12.5° (-3 db points)
Horizontal	20° (-3 db points)
Source Level	152 db
Pulse Length	10 ms to 60 seconds

Two array handling winches exist on the ship for lowering the transducer to a depth of 1200 feet. A detail description of the characteristics and capabilities of the ship and the project equipment is presented in the following sections of this report.

The complete system is installed on a modified tanker, formerly the USNS MISSION CAPISTRANO (T-AO 112). This was a T2-SE-A2 class ship operated under the Military Sea Transportation Service.

Modification of the ship was made under the cognizance of the Bureau of Ships and was started in October 1959. The actual work was scheduled to be carried out under three phases following the initial stage of feasibility study and preparation of guidance plans. The Phase I modification began in January 1960 and was completed in June 1960. It consisted of preparation of plans and completion of all ship modification work not requiring dry dock. This was done by Avondale Marine Ways, New Orleans. The Phase II modification was scheduled to complete the remaining ship work and to set in place the ship-installed project equipment not delivered in time for Phase I. Todd Shipyard, New Orleans, was the contractor for this work. The third phase, consisting of setting the transducer array in place and other related tasks, is to begin after completion of Phase II work in January 1961 and will continue for approximately two and one-half weeks. This work will be performed by the J. Ray McDermott Company, Incorporated, New Orleans.

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The resulting ship installation will be one of the largest, if not the largest, vessel devoted exclusively to acoustic research and development. Furthermore, it will contain outstanding capabilities for handling large transducers to great depths and to power these devices at depth.

The USNS MISSION CAPISTRANO contributes a part of the facilities required for Project ARTEMIS and for research and development in ocean surveillance. It should be noted that its modification and the equipment installed are not limited to just this program, however. They offer an exceptional tool for research and development of transducers, acoustic sources, propagation and oceanography.

The sections to follow describe in detail the ship's characteristics, the capabilities of installed equipment and the living facilities.

SHIP'S CHARACTERISTICS

The USNS MISSION CAPISTRANO, as existing prior to modifications, is shown in figure 1. The principal dimensions are as follows:

Length overall	532 feet, 6 inches
Length between perpendiculars	503 feet
Beam	68 feet
Draft, maximum	26 feet (approximate)
Freeboard, smallest	9 feet (approximate)

The maximum permissible draft has been reduced to twenty-six feet as a result of the extensive hull modifications which have been made to accommodate the project equipment.

Main Engine

The main propelling unit is turbo-electric and consists of one main turbine generator rated 6890 kilowatts, 1.0 power factor, 3500 volts, 60 cps, 3600 rpm and one propulsion motor rated 9000 hp, 173 rpm, 3500 volts, 1.0 power factor, 70 poles, continuous operation. It also is rated at 10,000 hp, 106 rpm, 3610 volts, 1.0 power factor continuous. The corresponding generator rating is 7650 kilowatts, 1.0 power factor, 3610 volts, 61.9 cps and 3715 rpm.

Boilers

The two main boilers are Babcock and Wilcox and are of the bent-tube, two-drum, common-wall type fitted with convection superheaters.

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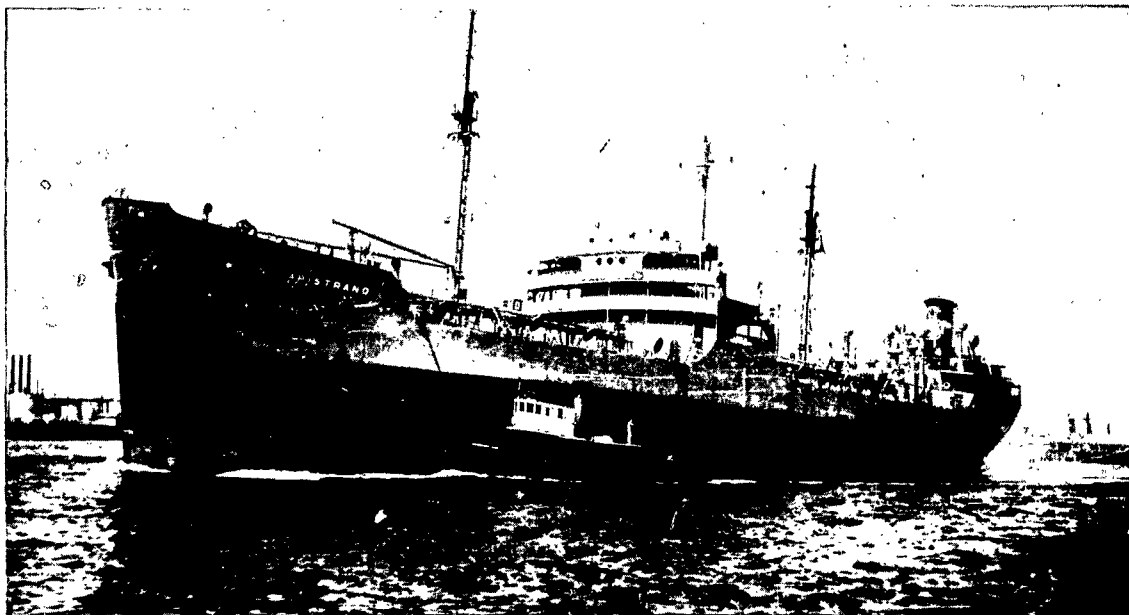


Fig. 1 - Mission Capistrano prior to modification

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The working pressure is 600 psi with steam temperature superheater outlet of 825 degrees fahrenheit. The heating surface per boiler is 8000 square feet.

Auxiliaries (Ship's Service)

The ship's service generators and other auxiliary equipment consists of the units as follows:

2 turbine driven, 535 kw auxiliary generator sets	
1 main condenser	2 pass. 9200 sq. ft. cooling surface
2 main feed pumps, turbine driven	Capacity 280 gpm
1 auxiliary feed pump, steam driven	Capacity 130 gpm
2 fuel oil service pumps, motor driven	Capacity 20 gpm
1 ship's service refrigerating system	Approx. 2570 cubic feet
2 evaporating plants	
Low pressure evaporator capacity	40 tons per day 10,800 gallons per day
High pressure evaporator capacity	10 tons per day 2,700 gallons per day

Cargo Pumps

A total of six cargo pumps existed for the purpose of pumping cargo, transferring it from one tank to another and for pumping ballast. These are as follows:

3 main cargo pumps	2000 gpm 100 lbs. horizontal centrifugal motor driven
2 cargo stripping pumps	400 gpm 100 lbs. horizontal gear-motor driven
1 cargo stripping pump	700 gpm, 14x14x12 vertical duplex steam

Performance

Prior to modification, the ship's performance was as follows:

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Maximum sustained speed	
Light	16.9 knots
Loaded	16.5 knots
Fuel consumption at cruising speed of 16 knots	336 bbls/day
Cruising radius at 16 knots with normal fuel capacity	8000 miles (nautical)

Information on the effect of the modification is not known; however, some reduction is expected due to nature of the changes. The results, though measurable, should be small. Other pertinent information is as follows:

Number of propellers	1
Total feed water	258.1 tons
Total fresh drinking water	63.6 tons
Diesel fuel oil capacity	53,437 barrels
Bunker fuel oil capacity	20,867 barrels

Capacity and Location of Tanks and Voids

Extensive modification to the internal arrangement of the ship was necessary in order to create the required space for project equipment. As a result, the center tanks from number two through nine, inclusive, were lost as storage area. Other tanks were also modified but to a lesser extent so they continue to serve for fuel oil or ballast. The resulting capacities and location of various tanks and dry storage areas are presented in Tables II, III and IV.

TABLE II - FUEL OIL TANKS

<u>Tank No.</u>	<u>Location (FR)</u>	<u>Gallons</u>	<u>Barrels (42G)</u>
1 - P	71 - 73	106,470	2,535
1 - S	71 - 73	106,764	2,542
2 - P	68 - 71	126,000	3,000
2 - S	68 - 71	129,612	3,086
Wing tank - P	36 - 46	104,748	2,494
Wing tank - S	36 - 46	104,748	2,494
Deep tank - P	75 - 89	99,036	2,358
Deep tank - S	75 - 89	99,036	2,358
	Total fuel	876,414	20,867

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TABLE III - DIESEL OIL TANKS

<u>Tank No.</u>	<u>Location (FR)</u>	<u>Gallons</u>	<u>Barrels (42G)</u>
3 - P	65 - 68	151,494	3,607
3 - S	65 - 68	162,960	3,880
4 - P	62 - 65	157,080	3,740
4 - S	62 - 65	168,924	4,022
5 - P	59 - 62	158,130	3,765
5 - S	59 - 62	169,092	4,026
6 - P	56 - 59	158,130	3,765
6 - S	56 - 59	169,512	4,036
7 - P	53 - 56	163,842	3,901
7 - S	53 - 56	169,176	4,028
8 - P	50 - 53	155,652	3,706
8 - S	50 - 53	167,118	3,979
9 - P	47 - 50	140,744	3,351
9 - S	47 - 50	152,502	3,631

Total Diesel Oil 2,244,354 53,437

TABLE IV - DRY CARGO

<u>Space</u>	<u>Deck</u>	<u>Frames</u>	<u>Cu. Ft.</u>
Cem. & Mud S.R. - CL	2nd deck	76 - 89	15,000
Stbd. side	1st platform	59 - 60	1,650
Elec. S.R. - Port	1st platform	62 - 63	1,650
Bulk. S.R. - CL	2nd platform	62 - 65	4,000
Aft S.R. - CL	Bel. Steer. Gr. Plat.	5 - 9	600
Bulk. S.R. - CL Fwd	1st platform	89 - 97	3,000

Total volume dry cargo spaces 25,900

SHIP'S PERSONNEL COMPLEMENT

The ship will be assigned a total complement of fifty-five men by the Military Sea Transportation Service to man all equipment and facilities required of the ship in its capacity to serve the needs and requirements of the project. In addition to these functions, the ship's force will be expected to operate all deck machinery, such as winches, cable handling machinery and other similar equipment peculiar to the needs of the project as well as the generator and prime mover supplying power to the project equipment. The ship's complement to provide these services will consist of sixteen officer, five chief petty officers and thirty-four men assigned in accordance with the list of Table V.

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TABLE V - SHIP'S COMPLEMENT

Deck Department	17
1 Captain	
1 First officer	
1 Second officer	
1 Third officer	
1 Fourth officer	
1 Radio officer	
1 Boatswain	
6 Able bodied seamen	
1 Able bodied seaman maintenance	
3 Ordinary seamen	
Engine Department	24
1 Chief engineer	
1 First assistant engineer	
1 Second assistant engineer	
1 Third assistant engineer	
1 Fourth assistant engineer	
3 Licensed junior engineers	
1 Chief electrician	
1 Second electrician	
1 Deck engineer machinist	
1 Engine utilityman	
3 Firemen, watertenders	
3 Wipers	
6 Oilers	
Steward Department	12
1 Chief steward	
1 Chief cook	
1 Cook, baker	
1 Second cook	
2 Messmen	
6 Utility men	
Purser Department	2
1 Purser	
1 Yeoman storekeeper	
Total ship's complement	55

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PROJECT PERSONNEL COMPLEMENT

Personnel assignment for operation of the acoustic source and related equipment will depend on the requirements of each experiment in progress. The major part of the project equipment is complex devices requiring careful, intensive training to provide qualified operating personnel. A crew of six men has been obtained under contract to maintain and operate all of the electronic equipment as well as instrumentation and controls associated with the transducer array. It is anticipated that this crew of Navy technicians may increase to ten or twelve men if and when twenty-four hour per day operation occurs. These personnel are being provided under a Navy contract with the Welex Corporation.

TABLE VI - PROJECT COMPLEMENT

Scientists	5 to 11
Navy technicians	6 to 12
Total project complement	17

LIVING AND MESSING FACILITIES

Quarters are provided in the after and center section of the ship for fifty-five officers and men and for seventeen scientists and technicians. Private staterooms are provided in the center deckhouse for each officer of the deck department and the purser. Similarly private staterooms are provided in the after deckhouse for each officer of the engine department and for the chief cook. The remainder of the ship's force are also provided staterooms in the after deckhouse.

Quarters for a total of seventeen scientists and technicians are provided in the center deckhouse. This consists of a private stateroom for the senior scientist and eight two-man staterooms.

Messing facilities are in two separate rooms: one for officers, scientists and technicians and one for petty officers and crew. These, along with the galley, are located in the after deckhouse.

Recreation and lounge facilities are provided also, in a similar manner to the mess facilities. The area for officers and technical personnel is located in the same general area as the staterooms for scientists and technicians.

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In addition to the normal ship's facilities, a laundry room is located in the area of the technical personnel staterooms. This laundry has an automatic washer, dryer, ironing board and double sink.

GENERAL ARRANGEMENT PLANS

The general arrangement of quarters, messing facilities, ship's equipment, project equipment, deck machinery and other related items are shown on the general arrangement plans of figures 2, 3, 4, 5 and 6. It will be noted that the arrangement of the basic ship's facilities and quarters are unchanged.

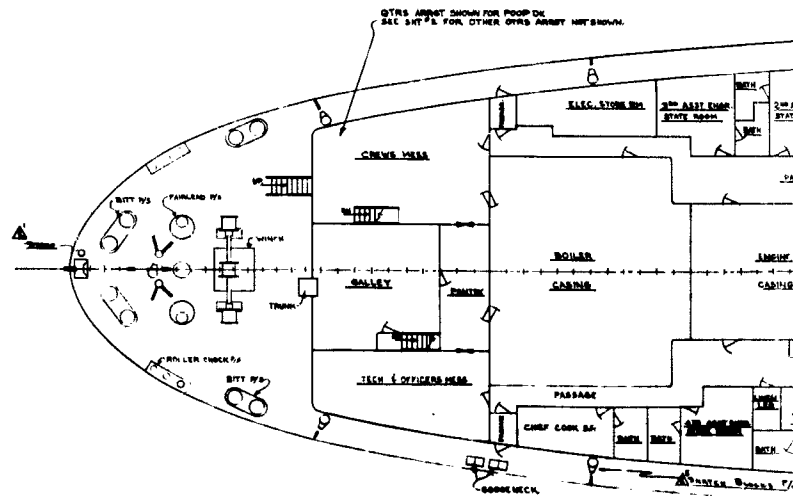
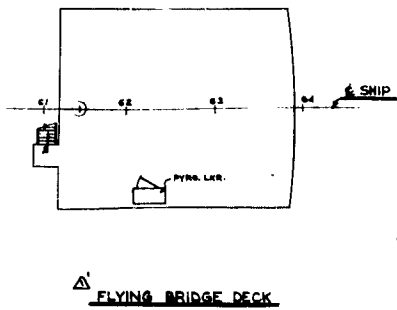
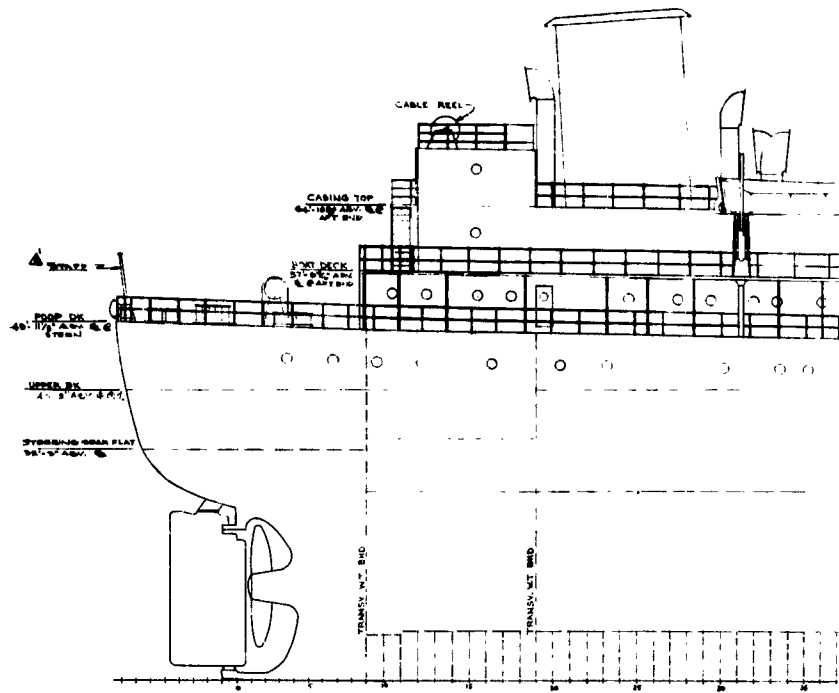
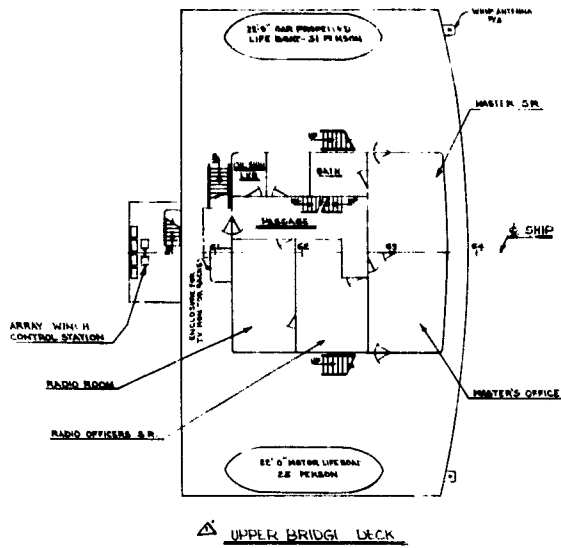
The modification of the ship for project equipment has taken place on the upper deck within the center deckhouse to provide quarters and recreation room for scientists and technicians, and also between frames 47 and 68 where the center tanks have been completely modified. It is in the latter areas which were formerly occupied by center tanks two (2) through nine (9) that project equipment is located. In addition, numerous items of deck equipment have been installed on the upper deck in this same general area. The extent of the modification, detailed description of the equipment and its characteristics are presented in the sections to follow. Appendix I lists all of the project equipment and identifies it by an assigned unit number.

PROJECT EQUIPMENT

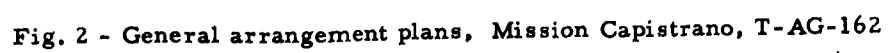
The project equipment installed on the USNS MISSION CAPISTRANO is basically a complete acoustic source composed of all equipment from source of power to the transducer. In addition, it consists of the required winches, cable machinery and other pertinent equipment necessary to lower and raise a one million pound object to a depth of 1200 feet and to supply electrical power to the device at that depth. Deck machinery is also provided for precise mooring in deep water.

A block diagram of the acoustic source is shown in figure 7. It is to be noted that there are three basic parts to the system. These are:

1. the fixed shipboard equipment consisting of the source of power, amplifier and controls,



1

[illegible]

3

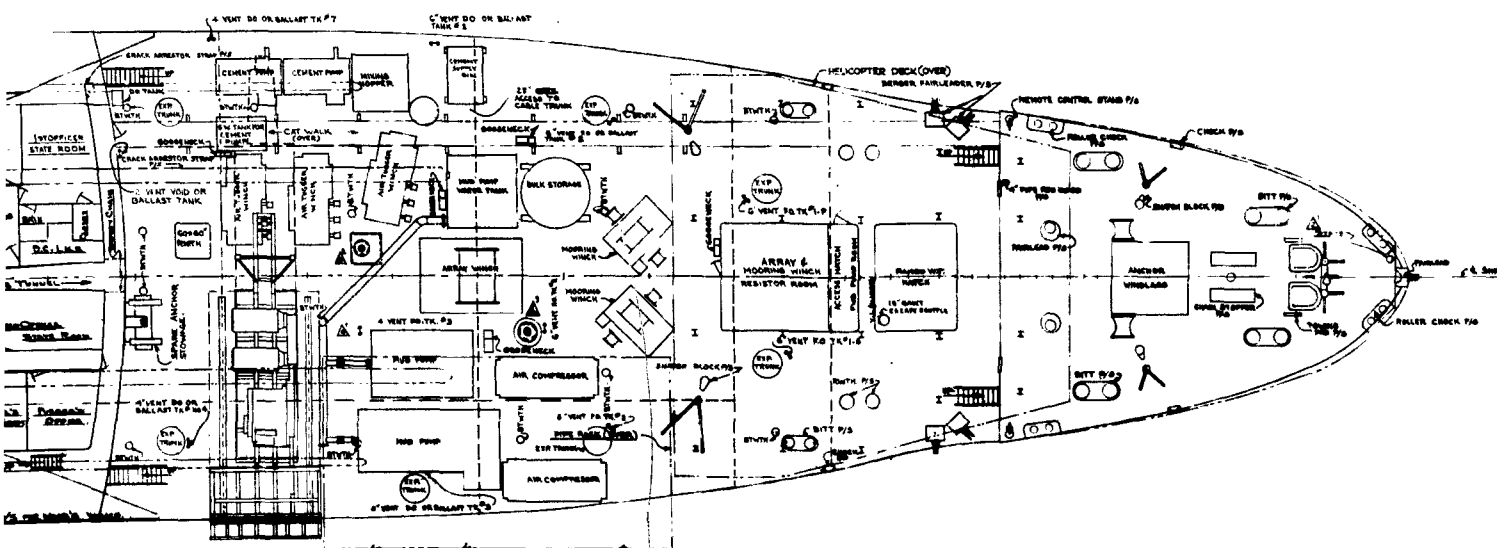
USS NAUTILUS (SSN-576)

Side Elevation Labels:

- RADAR ANTENNA
- WHIP ANTENNA
- 35' TWIN BOOM
- 15' TWIN BOOM
- ABRAXAS POWERING CONTROL STATION
- BRIDGE DK
- UPPER DK
- 2ND DECK @ SHIP ONLY
- 1ST PLATE @ SHIP ONLY
- 2ND PLATE @ SHIP ONLY
- PIPE RACK
- DRILLING RIG IN STOWED POSITION
- TRANSVERSE MT. END
- TRANSVERSE MT. END
- TRANSVERSE MT. END
- TRANSVERSE MT. END

Deck Plan Labels:

- ARRAY WELL DOOR STRUCTURE
- QTRS. ARRAY SHOWN FOR BRIDGE DECK
- 15' VENT DO OR BALLAST TANK #2
- 15' VENT DO OR BALLAST TANK #3
- 15' VENT DO OR BALLAST TANK #4
- 15' VENT DO OR BALLAST TANK #5
- 15' VENT DO OR BALLAST TANK #6
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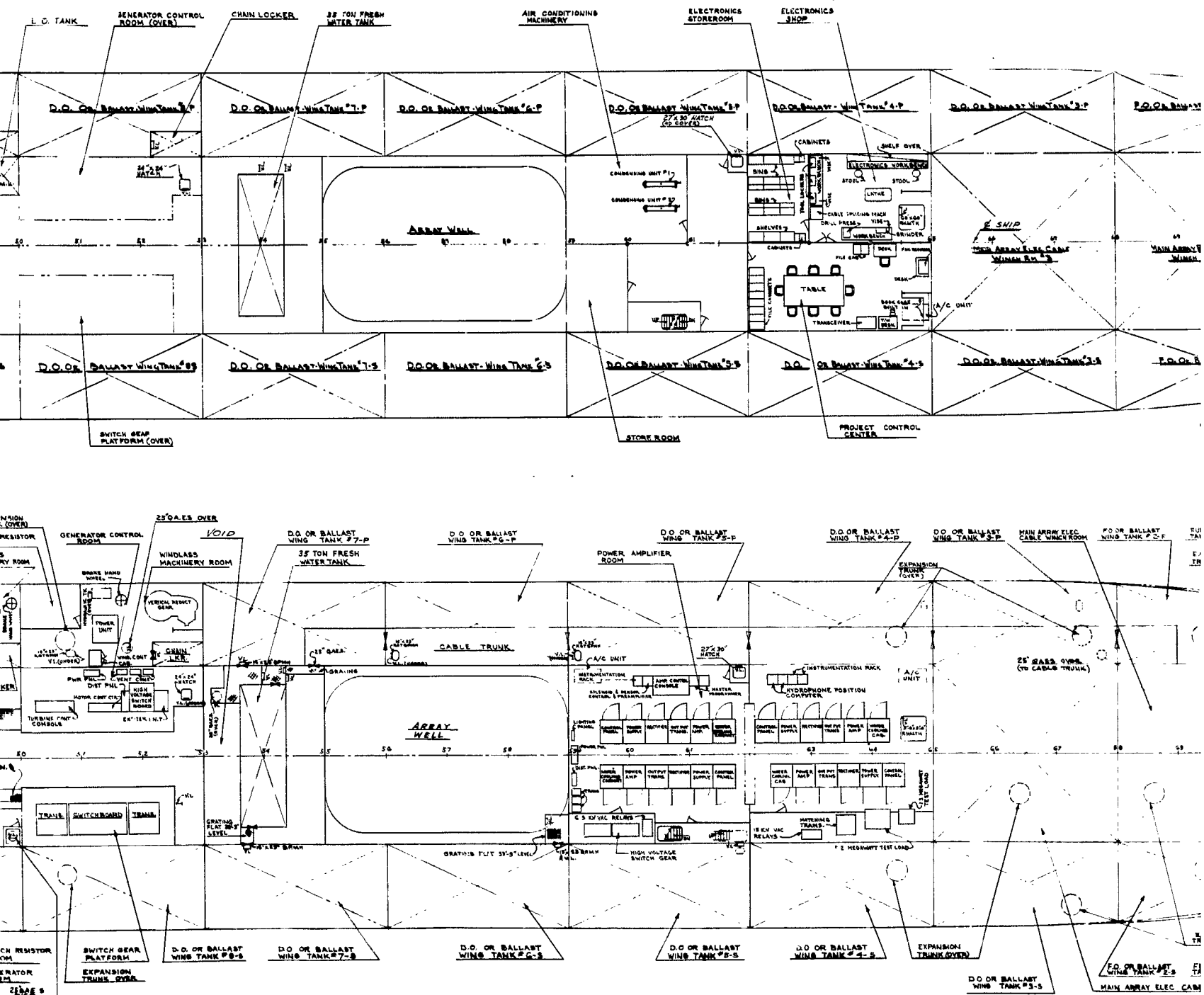
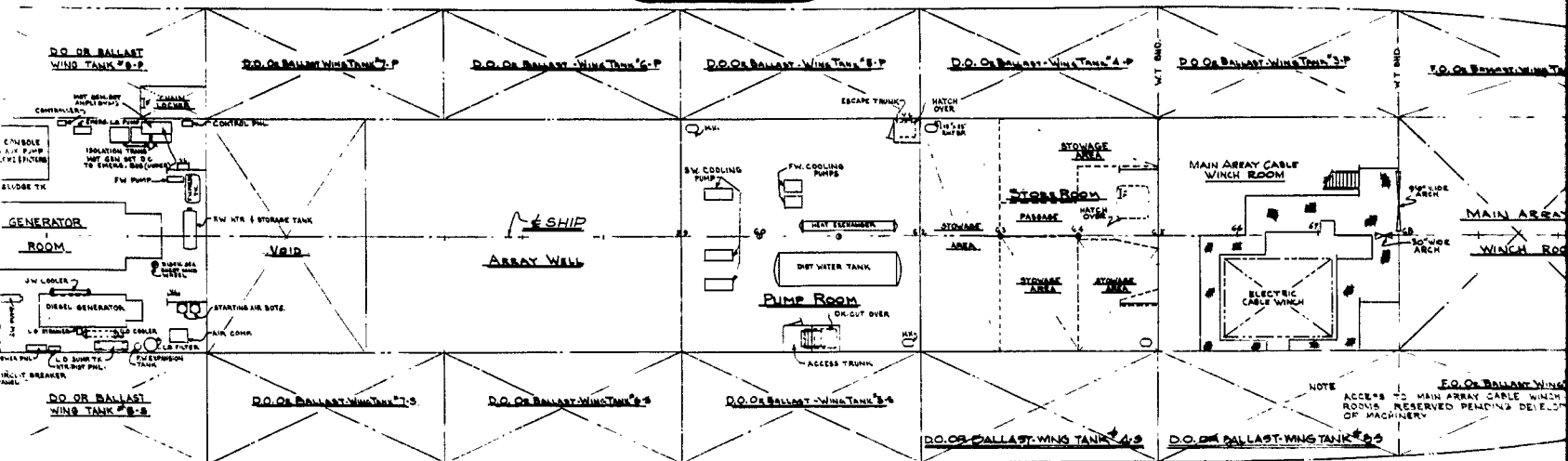


Fig. 3 - General arrangement plans, Mission Capistrano, T-AG-162

2



2ND PLATFORM

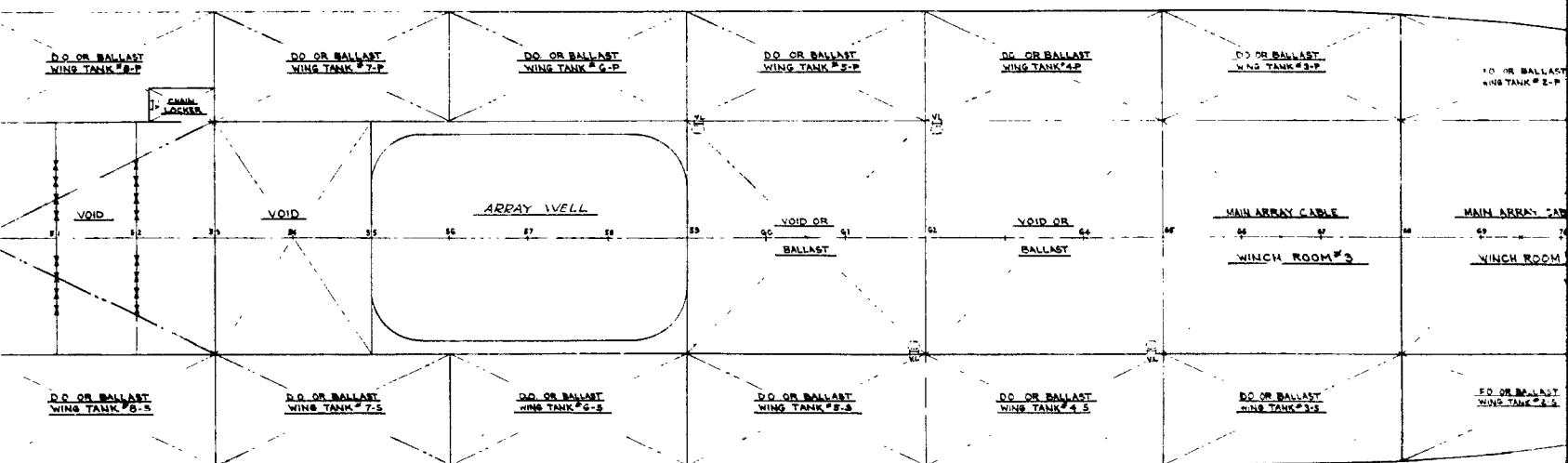
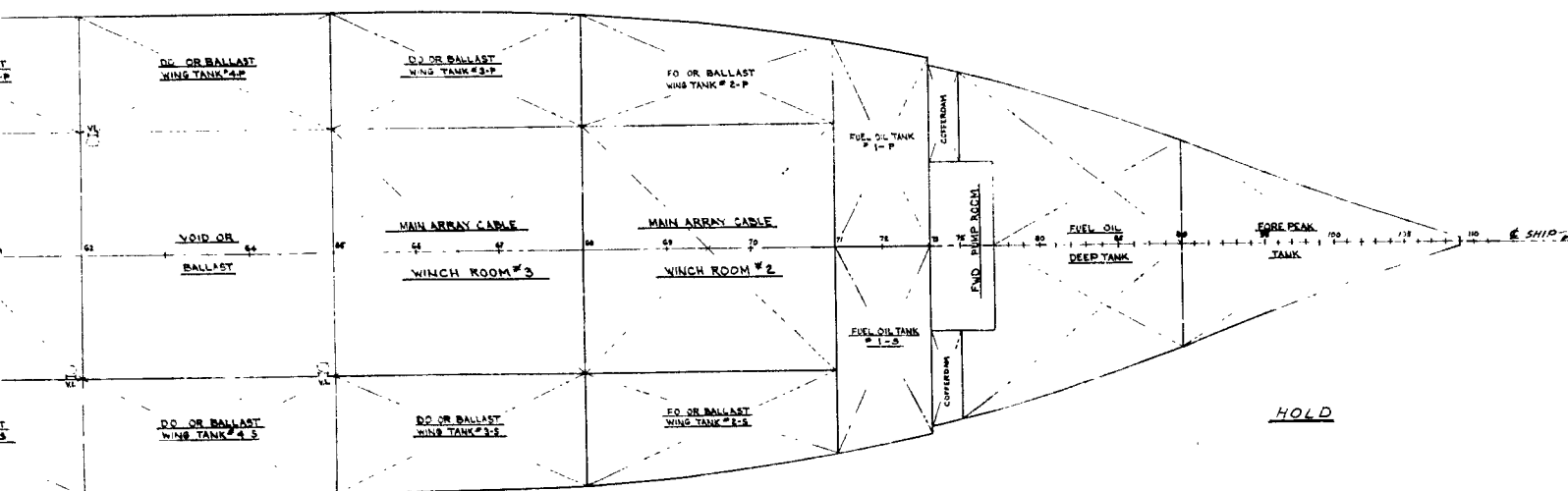
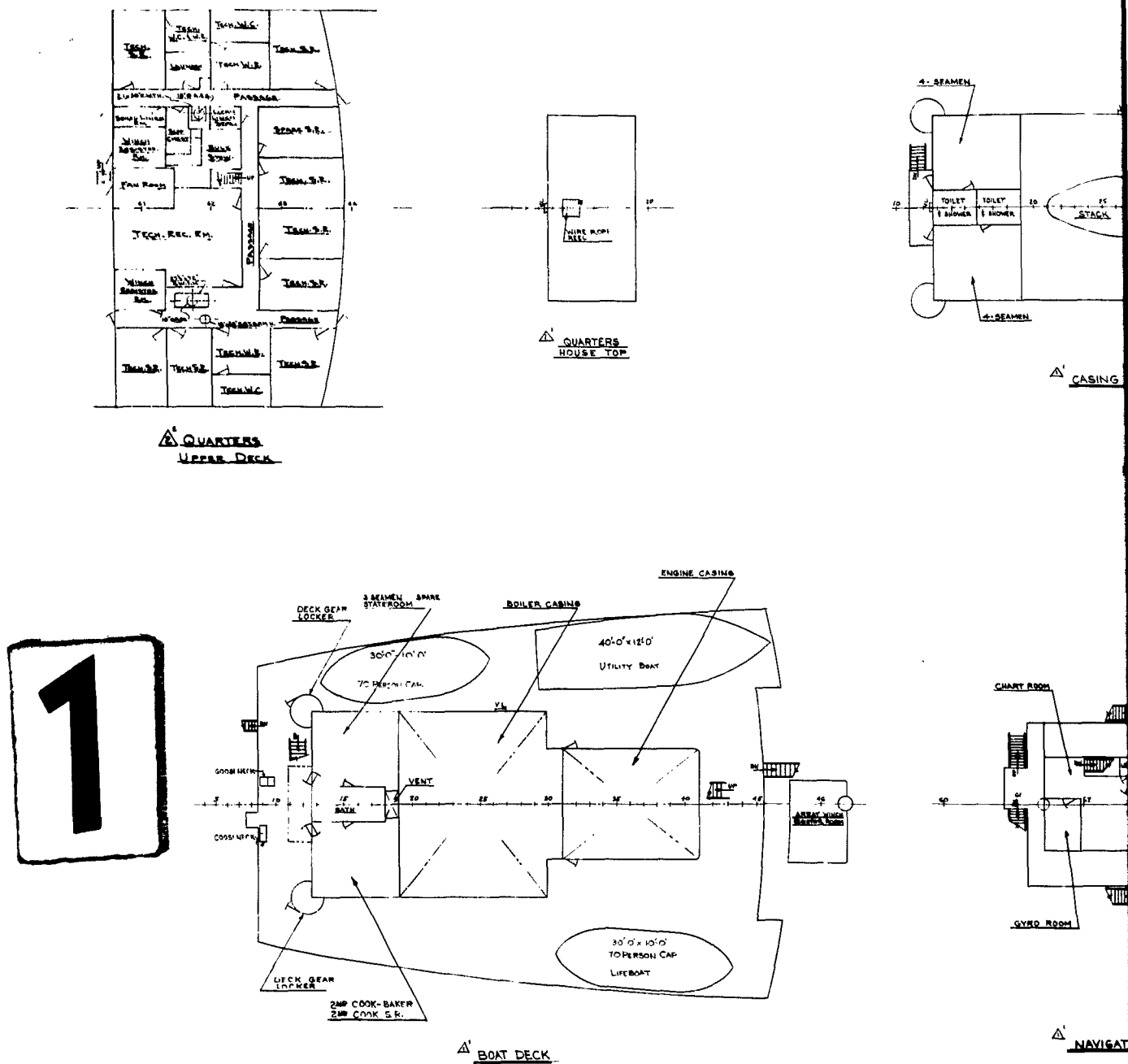


Fig. 4 - General arrangement plans, Mission Capistrano, T-AG-162

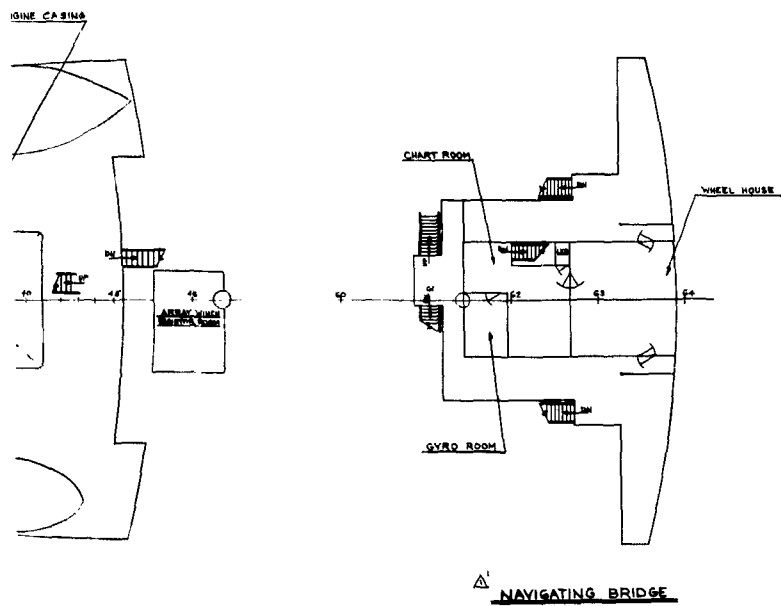
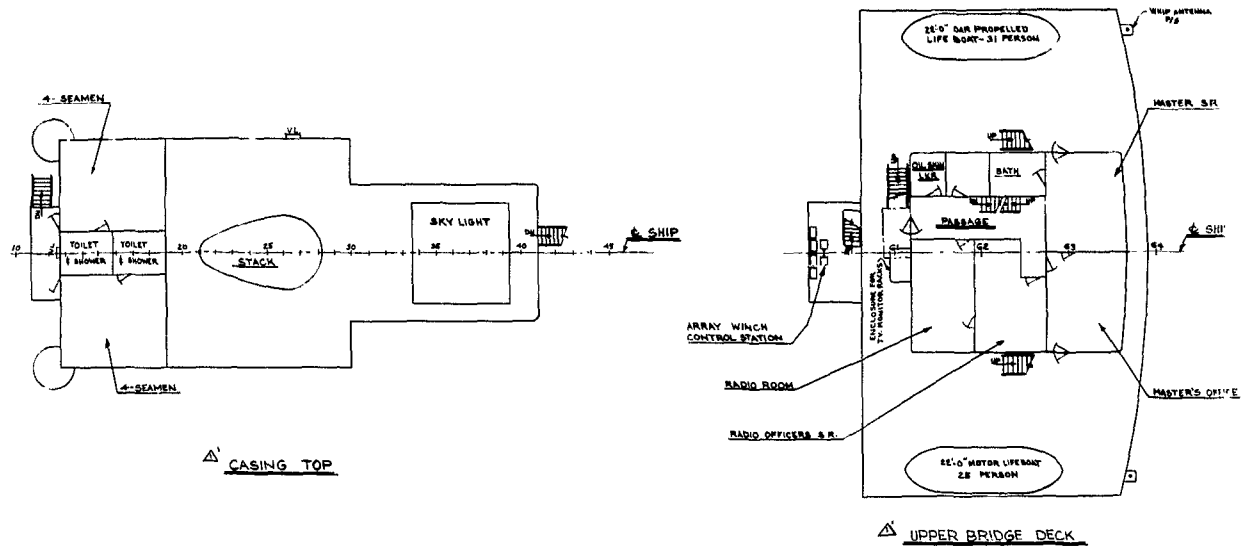




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Fig. 5 - Deck arrangements above upper

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2

Fig. 5 - Deck arrangements above upper deck

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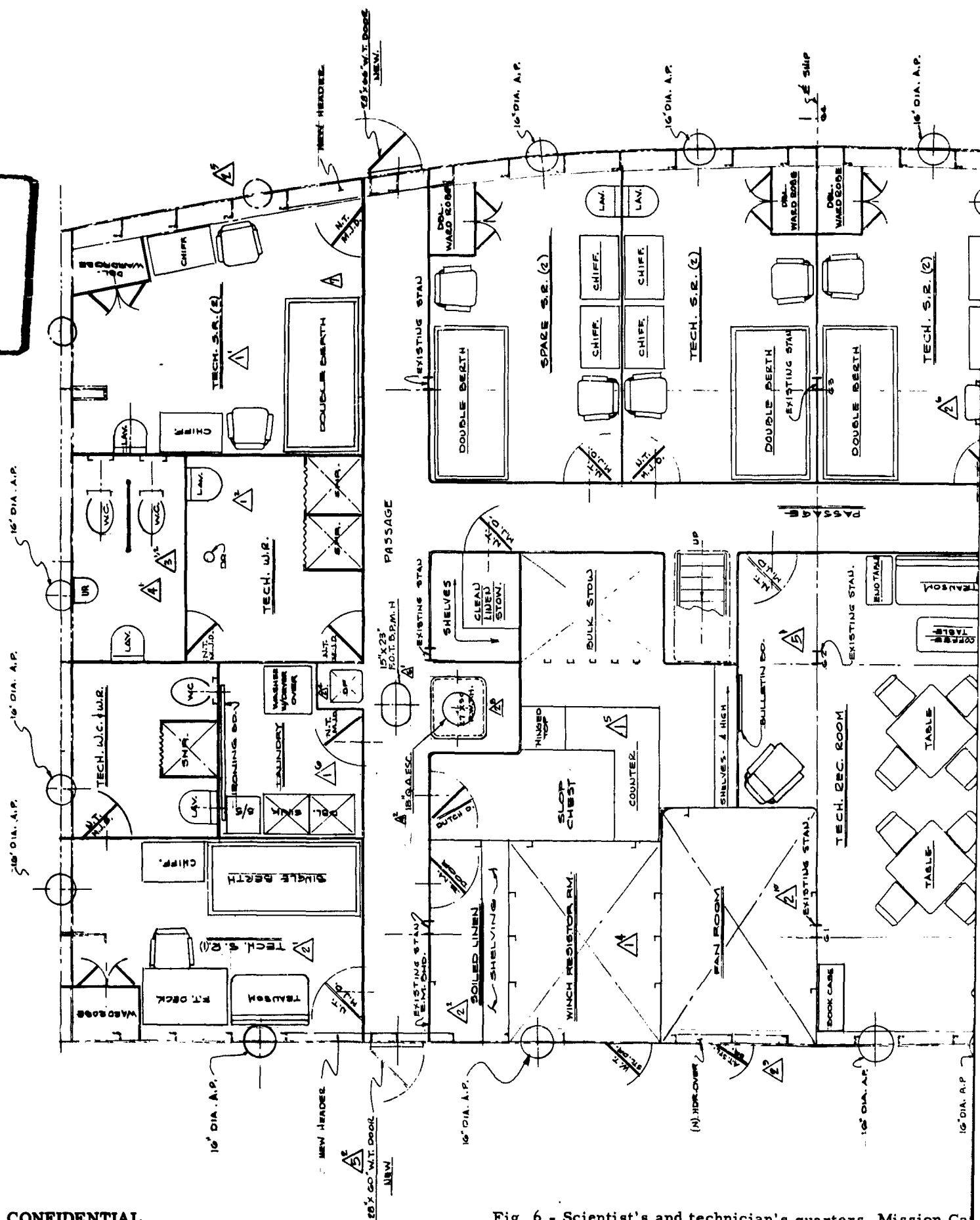
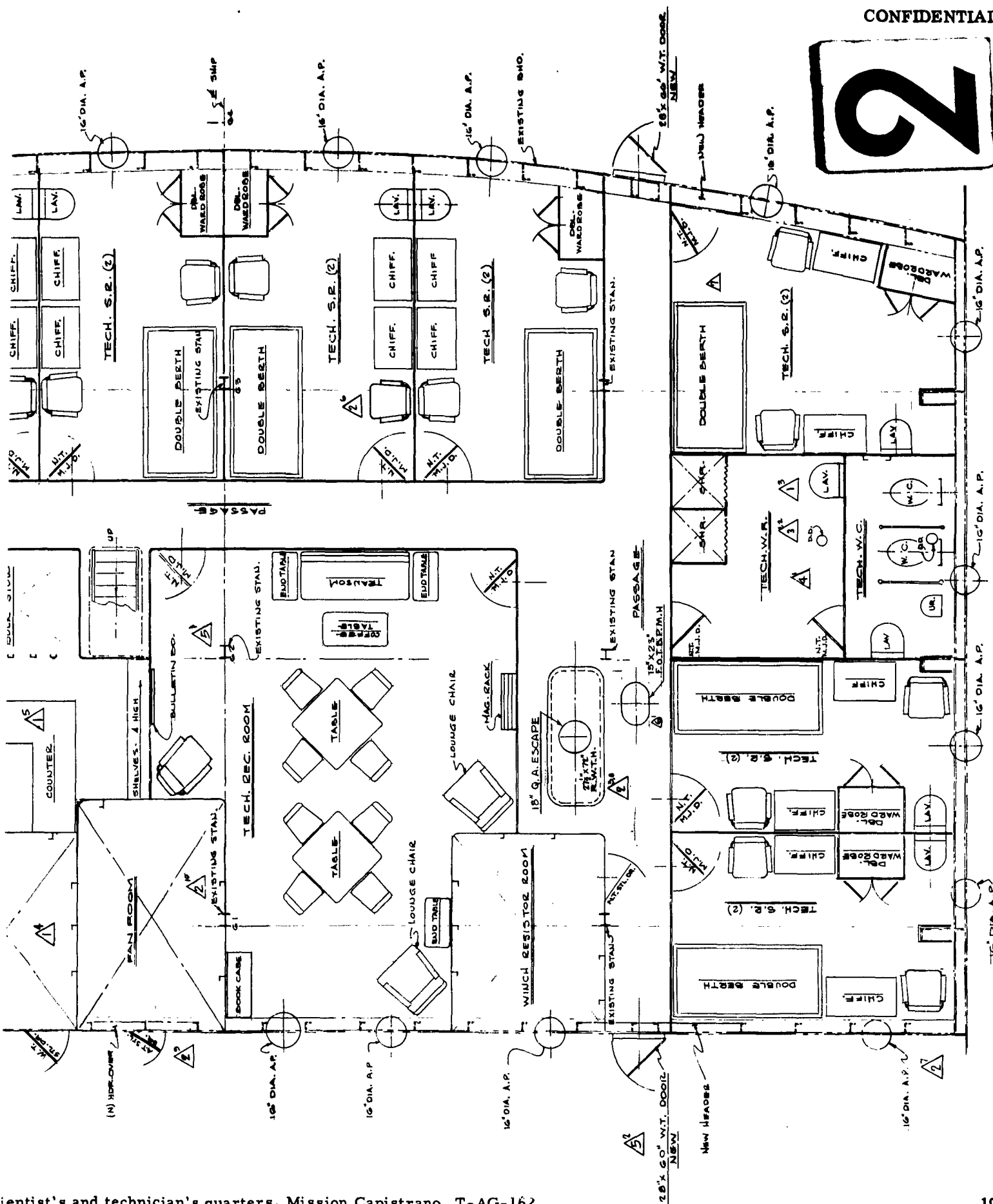


Fig. 6 - Scientist's and technician's quarters, Mission Ca



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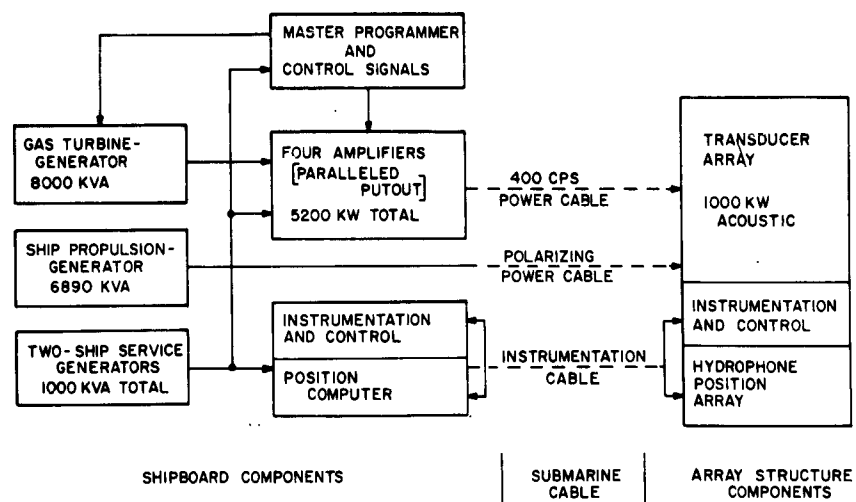


Fig. 7 - System block diagram

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2. the submarine cables, and
3. the transducer array consisting of transducer, electrical components, controls and instrumentation.

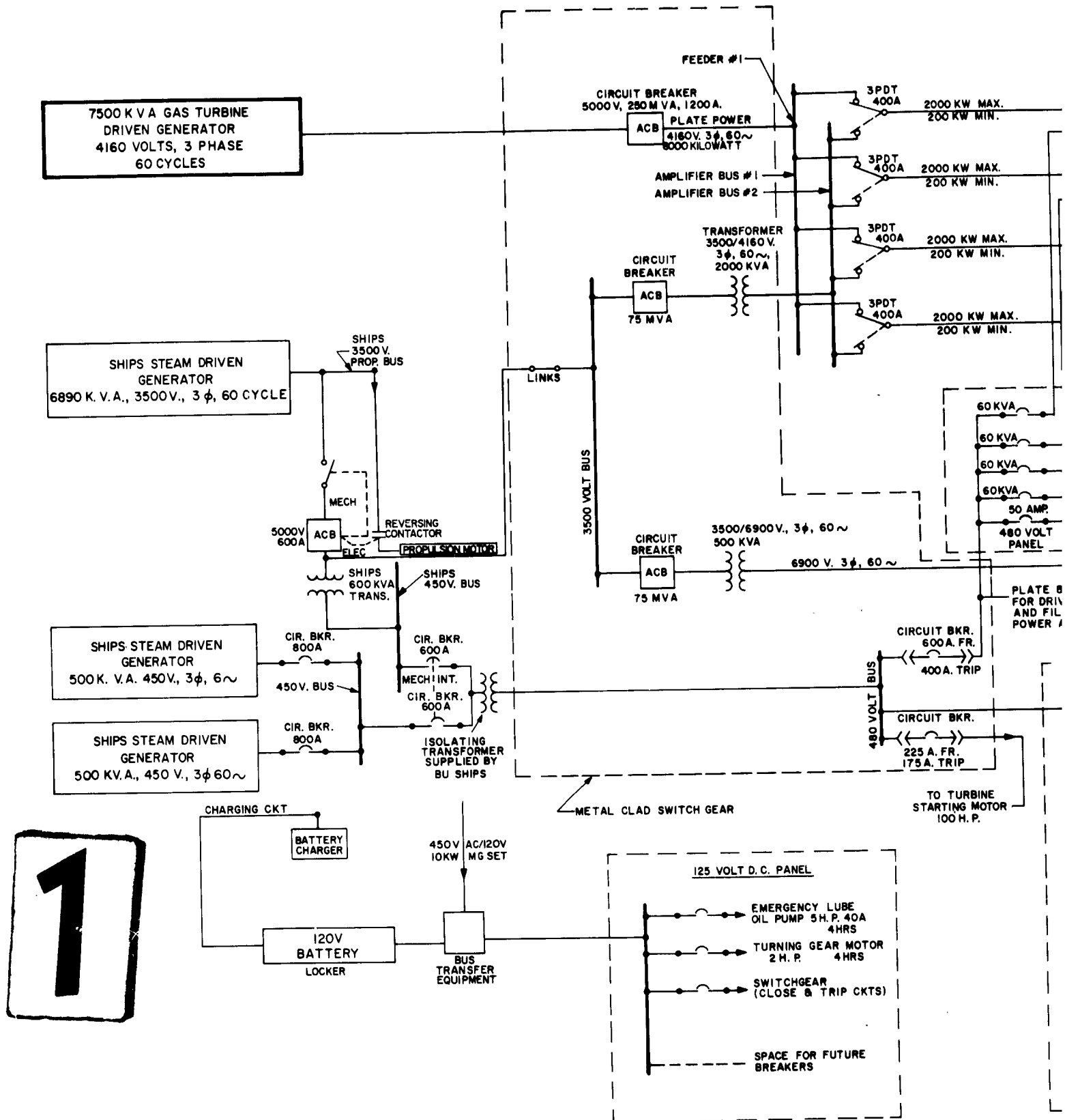
Greater detail of the system component interconnection is shown in figure 8. By utilizing the ship's propulsion generator as well as a special 8000 kilowatt gas turbine driven generator, flexibility as well as increased reliability of operation has been obtained for operation of the acoustic source. Similarly, provisions are made at the output of the amplifiers for single or parallel operation of one, two, three or four amplifiers. The test loads permit component and system tests up to full power of 5200 kilowatts.

The USNS MISSION CAPISTRANO, formerly a T2-SE-A2 class tanker, was selected for this installation because it provided the required space for installation of these components and also afforded space and structural suitability for a large center well through which the transducer array could be lowered.

The location of the component parts of the project equipment is shown on the general arrangement plans of figures 3 and 4. The gas turbine generator is located between frames 47 and 53 in the area which was formerly center tanks nine and eight. Major switchgear associated with the power distribution and the control center for the turbine is located in this general area on platforms above the turbine foundation level. A 500 kilowatt diesel driven dc generator which supplies power for nine LST anchor winches is also placed in this area. This arrangement has placed all of the major power generation equipment in the after part of the ship for ease of operation, maintenance and distribution of power.

Handling of the transducer array is through a well located between frames 55 and 59. This well is cut through from the main deck to keel leaving an access area thirty feet by forty-eight feet for stowing, lowering and raising the array. Extensive modifications were required in the form of doubler plates to strengthen the hull prior to cutting the deck and bottom openings. These doublers were riveted to the areas as follows:

1. Main deck port and starboard - 40.8 pound steel doubler plate of butterfly configuration.



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Fig. 8 - System components

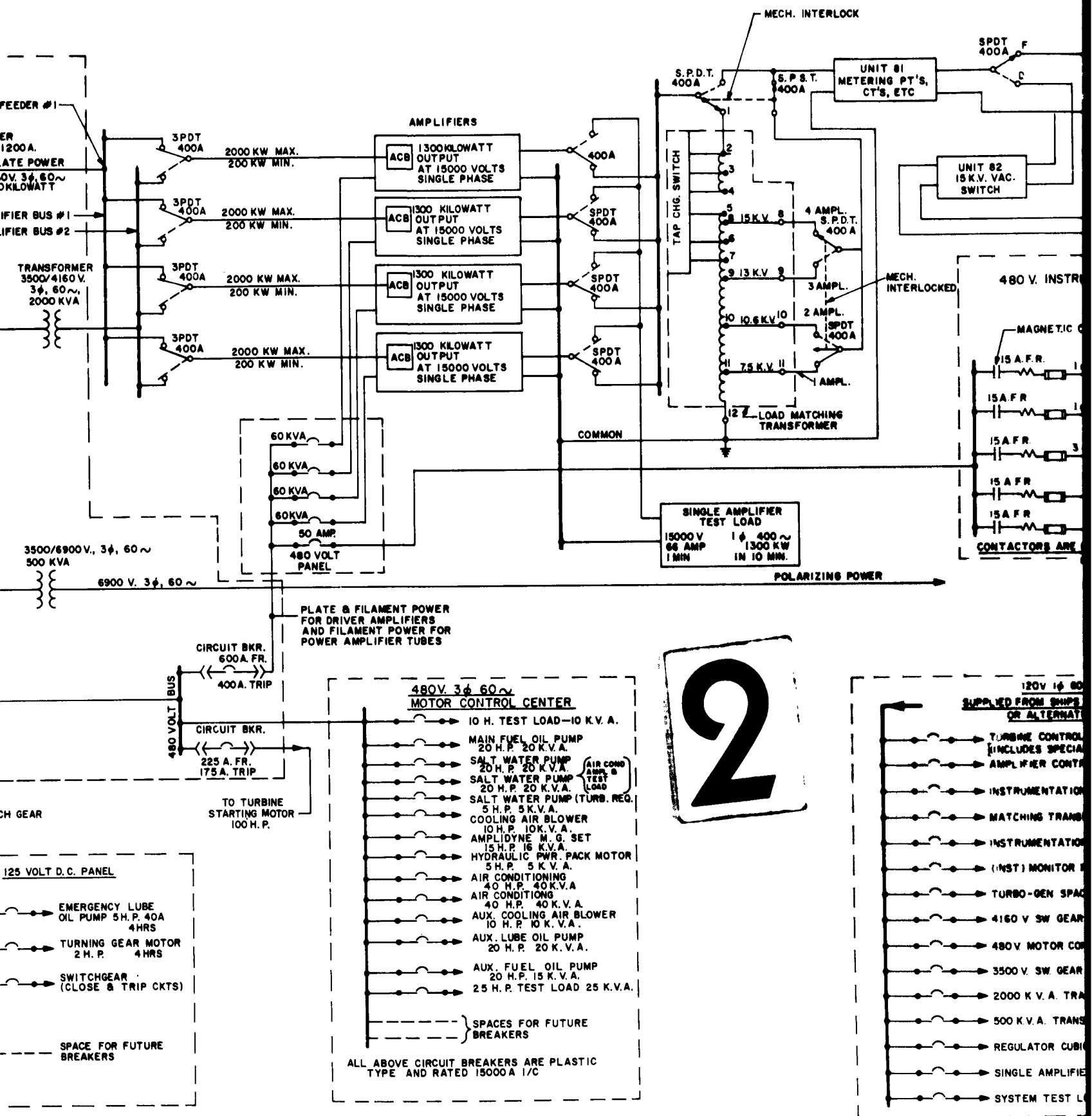
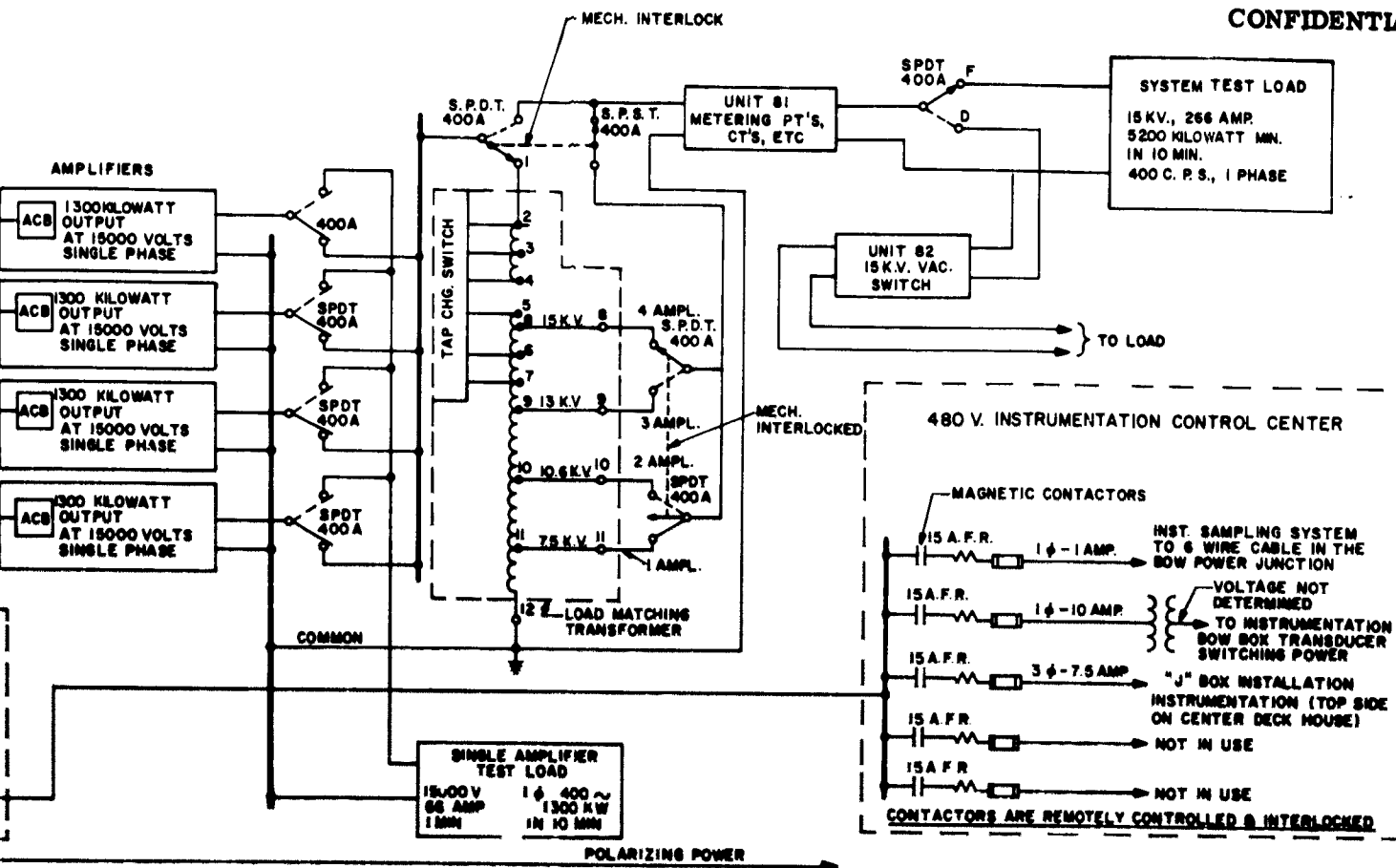
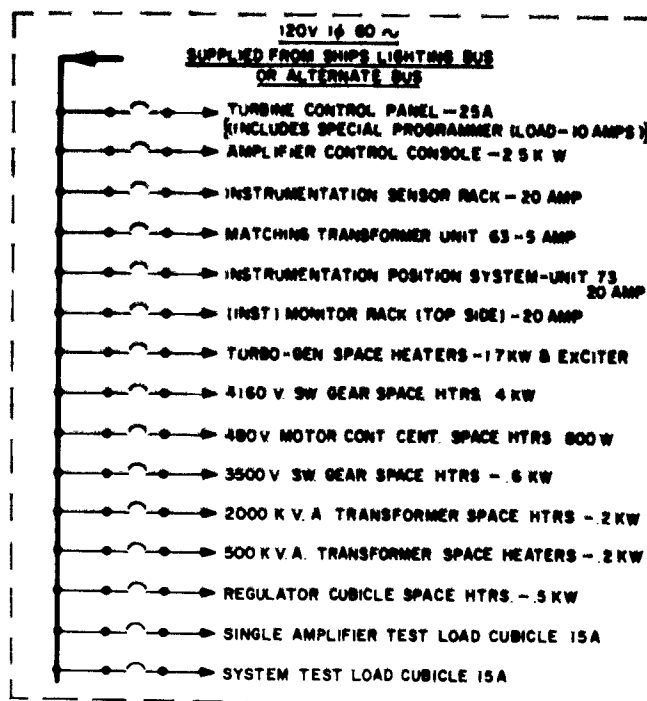
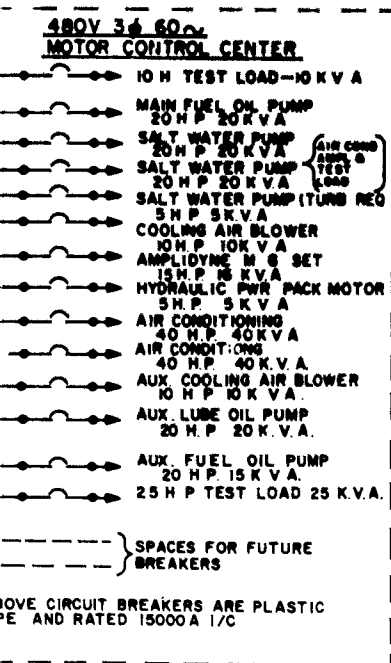


Fig. 8 - System components interconnection diagram



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2. Port side and starboard side - 40.8 pound steel doubler plate strap approximately 4.5 feet wide, and

3. Bottom port and starboard - 56.1 pound steel doubler plate of butterfly configuration.

Additional longitudinal girders are also added in the well area to aid further in making up for the moment of inertia lost by removal of the keel beam. These doubler plates for the deck, side and bottom are shown in figures 9, 10 and 11.

A structure was put at the side of the well to support sheaves over which the array support cable runs to support the bitter end. This structure also distributed the load in the ship structure to prevent stress and a concentration of loads within the well area.

Rolling doors are placed on the bottom of the ship to cover the well opening while the ship is underway. This does not seal the well area; however, it prevents the surging of water within the well which would result without the doors while underway in a heavy sea. These doors can be closed only when the area is clear of wire rope, cable or other obstacles.

Installation of the array well was made in this area of the ship to place it near the center of pitch. This reduces the amount of dynamic cable loading to near the minimum as caused by pitch. Furthermore, the two sets of sheaves for the lowering lines have been placed on a vertical plane running through the longitudinal axis. This position reduces the dynamic cable loading due to roll. Although dynamic cable loading due to ship motion has not been made zero, it has been minimized for both roll and pitch.

The amplifiers, control console and associated switches, transformers, test loads and other related electronics are located immediately forward of the array well. This is in what was formerly center tanks four and five and is between frames 59 and 65. Three decks were installed in this area below the main deck level. The first platform below the main deck contains all of the electronic equipment, test loads and the control console. Physical operation of the electronic system is exercised from this central location.

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Fig. 9 - Deck doubler plate - starboard



Fig. 10 - Side doubler plate - port

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A project control center is located on the platform below the amplifier room. This contains desk, table, filing cabinets and other comparable equipment. Adjacent to this area is an electronic workshop and storage area. The compressor equipment for the air conditioning of the amplifier space is also located on this deck.

The heat exchanger for the single amplifier and the four amplifier test loads are placed on the third platform below the main deck. Other space in these two areas is utilized for stowage of supplies and materials.

Selection of this area beneath the center deckhouse for the amplifier was based primarily on the best compromise for installation of this equipment and for the cable handling machinery. However, it does provide for ease of access from the scientists and technicians quarters and improved ship motion characteristics insofar as equipment acceleration, shock and vibration.

Three special cable handling drums are installed forward between frames sixty-five and seventy-one. One cable machine is located in the after compartment whereas two machines are in the forward compartments. The electrical cables are fairled aft from the respective cable drums over roller guides via a cable trunk on the port side of the ship to the well. This cable trunk is located beneath the main deck. Cable drum location in the forward area was selected because of the initial requirement for handling cables over the bow to a mooring tower and thence to a transducer installed on the ocean bottom. It should be noted that the necessary bow sheaves, roller guides and other equipment has not been installed at this time to accommodate this operation. However, when a firm decision is made to install the transducer in place, further alteration to the cable handling system will be made.

Several pieces of deck machinery have been installed for special purposes in connection with operation and installation of the project equipment. An anchor windlass of the BB 61 class has been installed on the port side in the vicinity of frame fifty. Seven LST stern anchor winches are located at several places on the main deck to meet needs for special mooring requirements. In addition, a two-drum tagline winch is also available for equipment handling and other special purposes.

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The general arrangement plans for the main deck, figure 2, show numerous pieces of equipment on the deck forward of the center deck-house. This equipment does not exist; however, foundations have been installed for the items listed on this plan. Early plans for the high power acoustic source called for installation of the transducer on the ocean bottom where it would serve as part of a fixed source. In order to accomplish the proper attachment of the transducer to its site, the foundation legs were to be drilled and cemented in place. Conventional drilling rigs, pumps, cementing facilities, etc., were to be modified for use at sea and then installed on the ship. It is for mounting these units that various foundations have been installed on the forward part of the main deck. Although the drilling equipment has not been installed, it can be done on relatively short notice. During the installation limited additional work is required to complete those foundations and platforms which will extend beyond the side of the ship. This includes the drilling pipe rack and the drill rig foundation.

There are many other details of the project equipment which are required to complete the description of its characteristics and limitations. These are presented for the several parts of the system in the section to follow.

Sources of Electrical Power

The sources of electrical power on the USNS MISSION CAPISTRANO are as follows:

- a. steam turbine generator
- b. auxiliary turbine generators
- c. gas turbine generator
- d. auxiliaries

A more complete description follows.

Steam Turbine Generator

The existing steam turbine generator (figure 12) has two ratings depending on its utilization. For propulsion usage, it is referred to as a 7650 kilowatt, 3610 volt, 3 phase, 1.0 power factor, 61.9 cycle, 3715 rpm unit. When providing power for main cargo pumps, it has a rating of 6890 kilowatts, 3500 volts, 3 phase, 1.0 power factor, 60 cycles at 3600 rpm. This unit is located in the engine room at about the second platform level between frames thirty and forty.

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Fig. 11 - Bottom doubler plate

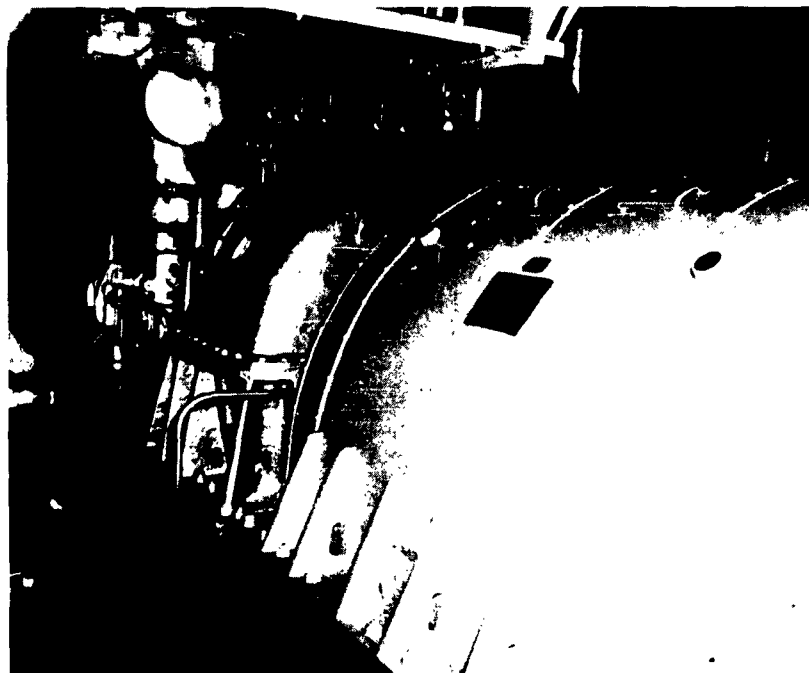


Fig. 12 - Ship's engine room - propulsion
steam turbine and generator

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Auxiliary Turbine Generators

There are two identical auxiliary steam-turbine-driven tandem generator sets consisting of three generators driven from a single turbine. (figure 13) The total electrical rating is 535 kilowatts which is available from each such auxiliary turbine as follows:

1. An ac generator rated at 400 kilowatts, 450 volts, 3 phase, 60 cycles, 0.8 power factor for ship's service,
2. A dc generator rated at 50 kilowatts, 120 volts for ship's service, and
3. A dc generator rated at 85 kilowatts, 120 volts for propulsion generator excitation.

These auxiliaries are also located in the engine room adjacent to the propulsion generator.

Gas Turbine Generator

The gas turbine, unit 26 (Clark Bros. Co modified model 302 dual shaft) and generator, unit 27 (Elliott Company) have a continuous rating of 6750 kilowatts, 0.9 power factor, 4160 volts, 3 phase, 60 cycles and 3600 rpm. This equipment is shown in figure 14 as it appears on the factory floor for tests.

Modification to the standard turbine consisted of additional compressor stages and new blade angles together with special electrohydraulic controls. These controls permit application and removal of a large step load without adversely affecting turbine life or causing excessive speed deviation. The load pulses are in the range from 100 kilowatts to 7200 kilowatts with on times from 100 milliseconds to one minute. The maximum continuous cyclic load is 8000 kilowatts for one minute and 800 kilowatts for nine minutes. Under these transient conditions, the frequency of the generator will not change by more than two percent on application or removal of the specific programmed load and will return to within one-half of one percent of its steady state value in approximately two seconds.

This transient response characteristic to step load application and removal are derived from the combination of a conventional closed loop speed governor and an open loop compensation from three additional valves. These valves are the blow-off valve which permits the hot gases to bypass the power turbine, the air inlet valve which provides for air mass flow control and an auxiliary fuel valve for the large load increments.

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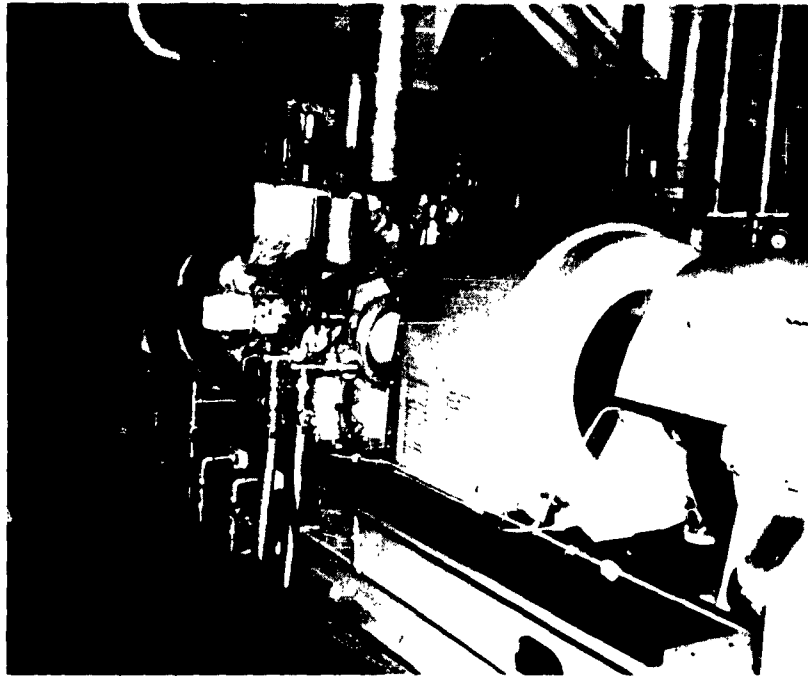


Fig. 13 - Auxiliary steam turbine and tandem generators

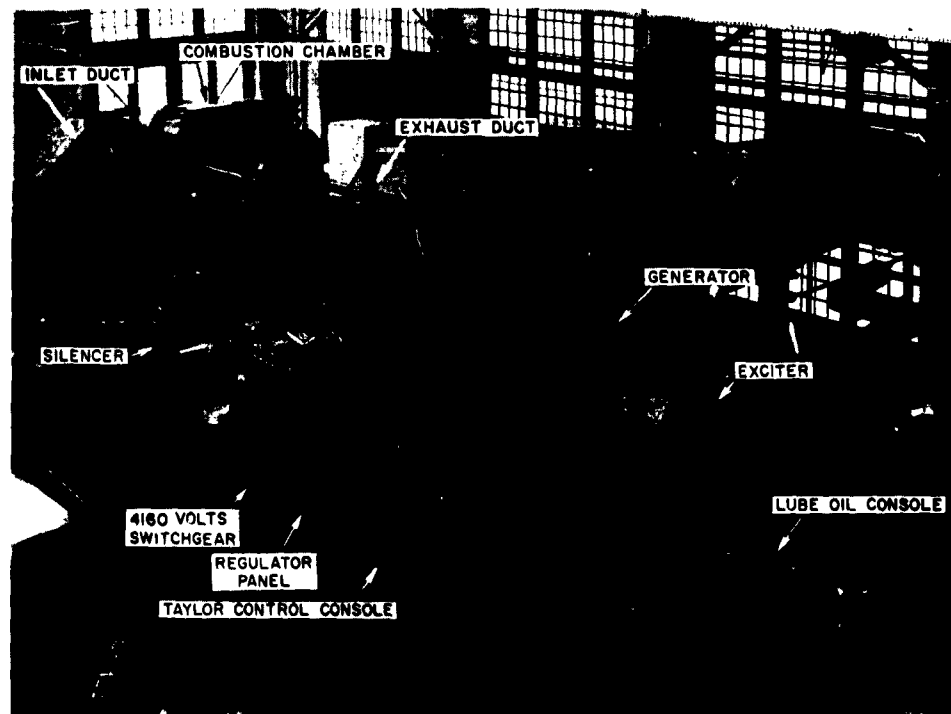


Fig. 14 - Gas turbine and generator on test

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The generator and exciter are both direct-driven from the gas turbine. Voltage control is effected by a conventional marine-type regulator with an amplidyne output (unit 35) to provide the required field control of the generator exciter. The voltage output of the generator deviates less than three percent on application or removal of the step loads noted above.

Reduction of noise level in the generator room is effected by inlet air silencers (units 145 and 146), one in each of the gas turbine intakes. In addition, the generator control room is acoustically and thermally insulated from the generator.

The voltage regulator panel, unit 34 (General Electric) and the turbine control console, unit 33 (Taylor) are located in the generator control room (frames 50 and 53) at about the second deck level within the turbine generator room on the port side. This prime mover includes separate lube (unit 31), fuel (unit 32) and hydraulic (unit 36) consoles which are located with the gas turbine generator in the generator room at about the second platform between frames 47 and 53. The gas turbine has a 100 hp electric motor with control cubicle (unit 30) for starting, butane gas for igniting and operates from diesel number one oil.

The general arrangement of the equipment in the turbine-generator room is shown in figure 15. This sketch views the layout from the starboard side. A view of the turbine generator control equipment and switchgear taken on the turbine test floor is shown in figure 16. This equipment is grouped in the generator control room (shown in figure 17 and arranged as shown in figures 18 and 19) together with the motor control center.

Auxiliaries

There are several auxiliary generators throughout the ship to meet special power requirements.

1. A 500 kilowatt, 240 volt dc diesel driven generator rated 125 percent for two hours with self-excited stabilized shunt connection is located in the generator room on the starboard side on the same deck near frame 53. This may be seen in figure 20 which was taken prior to setting the turbine generator in place.

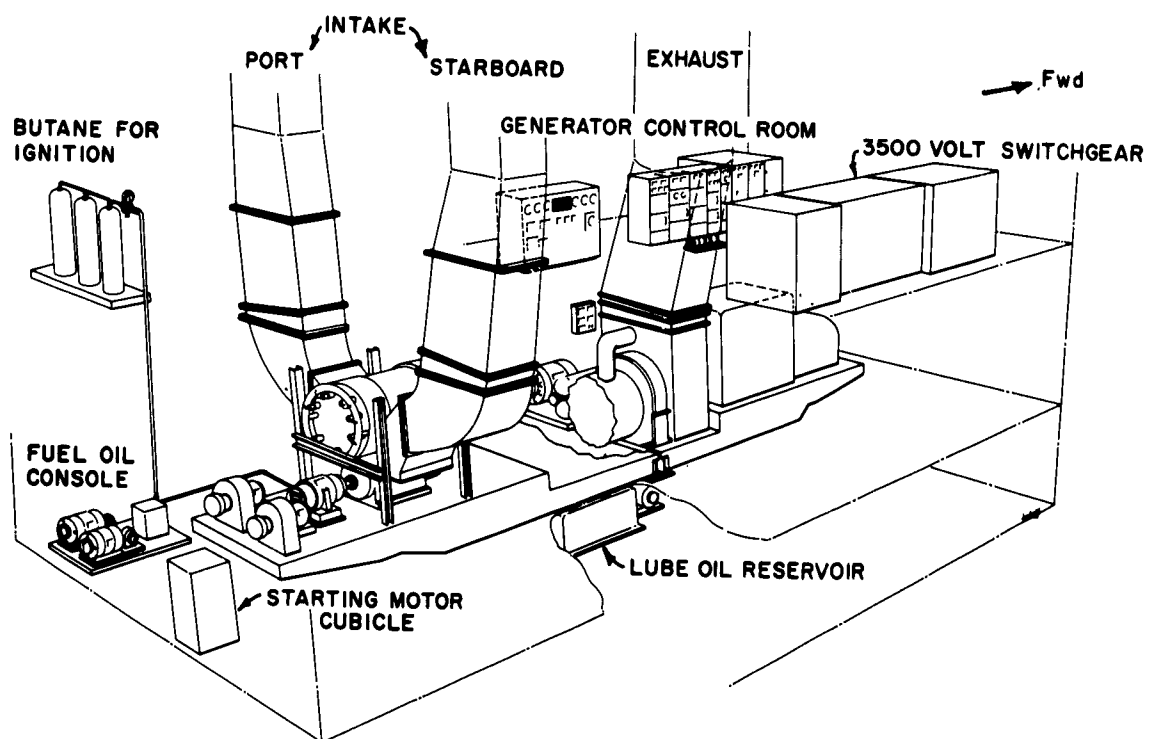


Fig. 15 - Generator room

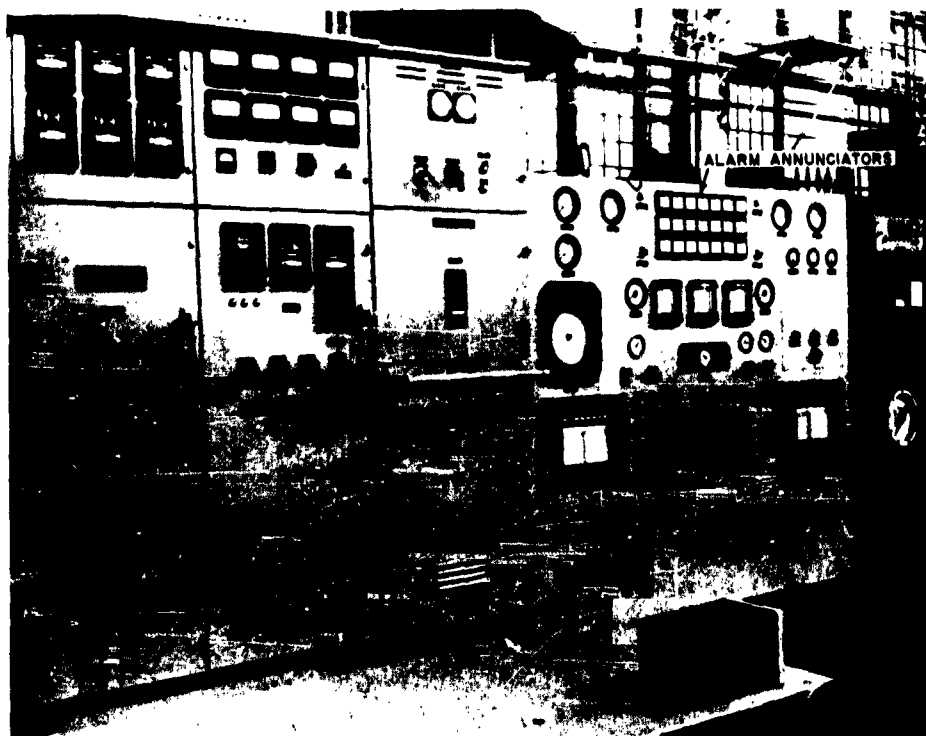


Fig. 16 - Turbine control console and switchgear during test at Olean



Fig. 17 - Generator control room as viewed from 3500-volt switchgear platform

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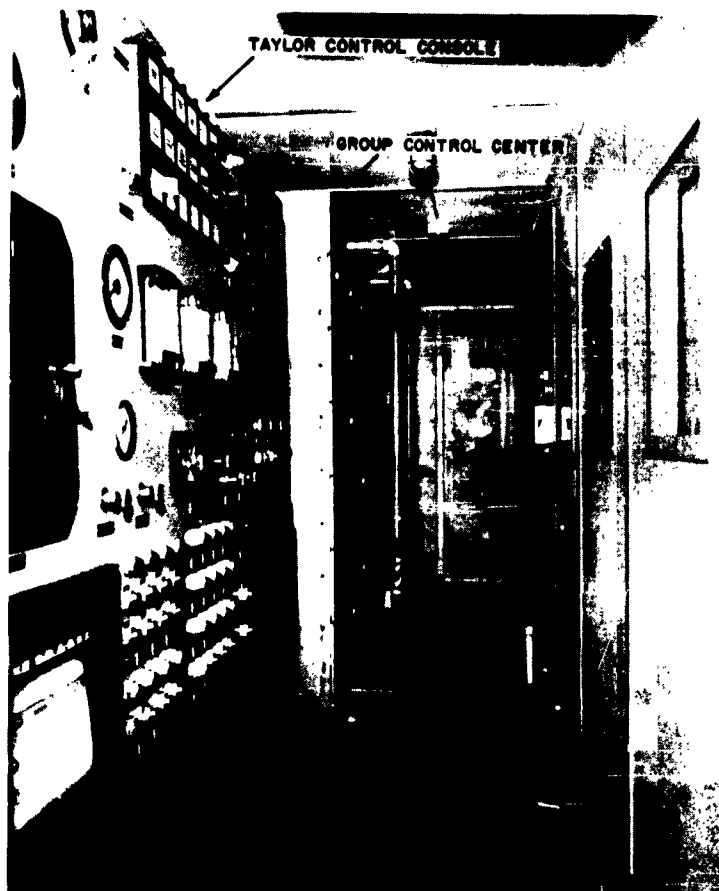


Fig. 18 - Interior generator control room
looking forward

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Fig. 19 - 4160 generator controls

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2. A ten kilowatt motor generator set, 120 volt dc, figure 21, is located at frame 53.

3. Ship's battery and the additional 120 volt dc battery is located in battery room locker.

4. A 60 kilowatt diesel-driven dc generator rated at 250 volts is provided to supply polarization power for the transducer. This set is mounted on the pipe storage rack at about frame 67 and will be used only during the operation involving two transducer modules. Following completion of this interim phase of test work, it will be removed.

Distribution System

The electrical distribution system used for project equipment on the USNS MISSION CAPISTRANO can be separated functionally as follows:

- Propulsion system
- Ship's service system
- Gas turbine-generator system
- Auxiliaries

The distribution system associated with each of these will be described in detail until a complete load listing is developed for each system. A schematic diagram of the entire interconnection of components is shown in figure 22.

Propulsion Control Switchgear

The output of the steam driven generator may be connected to either of two buses. The first of these connects the generator to the propulsion motor through a reversing contactor. This bus is referred to as the 3610 volt variable frequency bus. The second bus is available through a 5000 volt, 600 ampere breaker and disconnect switches (mechanically interlocked) and electrically interlocked with the propulsion motor contactor. This bus is referred to as 3500 volt, 60 cycle constant frequency and is used to provide power for ship's main cargo pumps. The 3500 volt switchgear is located on the elevated starboard platform in the generator room and is the only other load on this constant frequency bus. These two circuits are provided as follows:

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Fig. 20 - Generator room looking forward at deck level

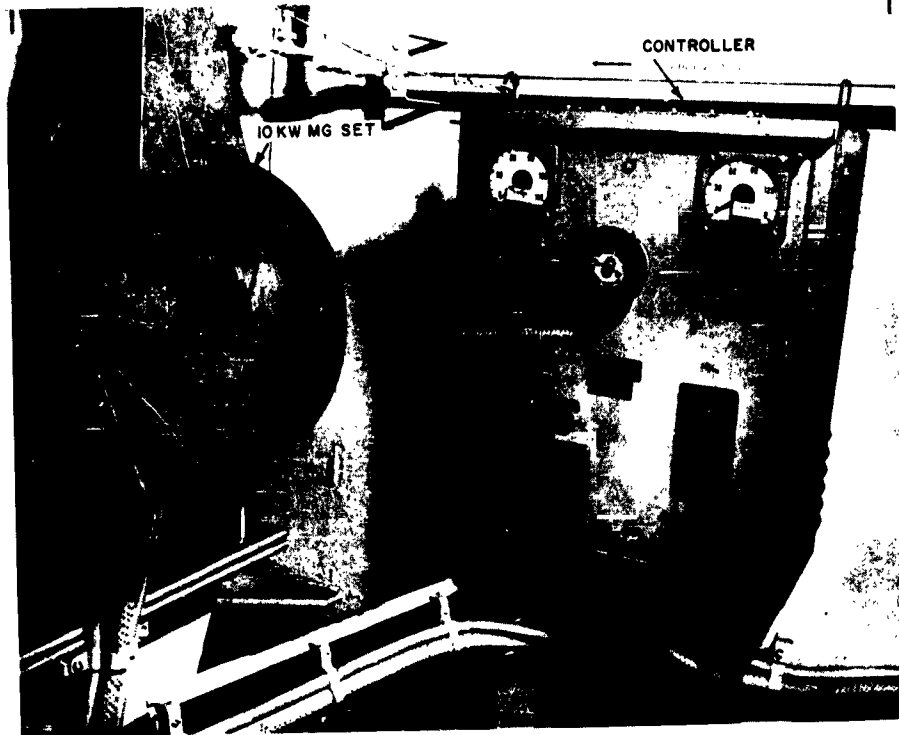


Fig. 21 - DC control power

HTRS) PNL 4-51-1

TENSION SW

V

BY PASS (LIMIT SW)

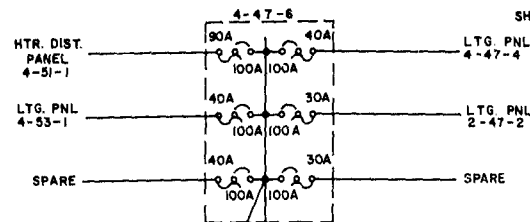
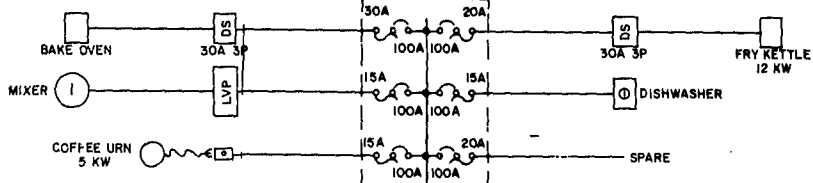
CH NO 4



LATHE (1/2) LVP

SHORAN MG SET

01-15-2
GALLEY PWR. PNL.



HTRS) PNL. 4-51-1

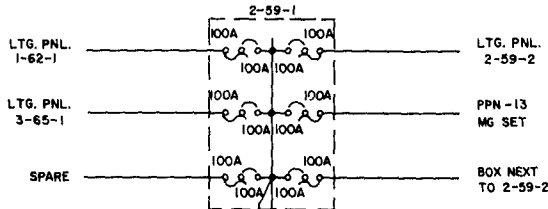
TENSION SW

W

RY-PASS (LIMIT SW)

INCH NO. 6

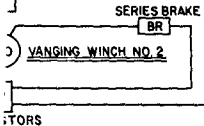
LIGHTING LOAD
CENTER PNL. FWD.



15V SUPPLY (FOR HTRS)

PNL 4-51-1

DRUM SW



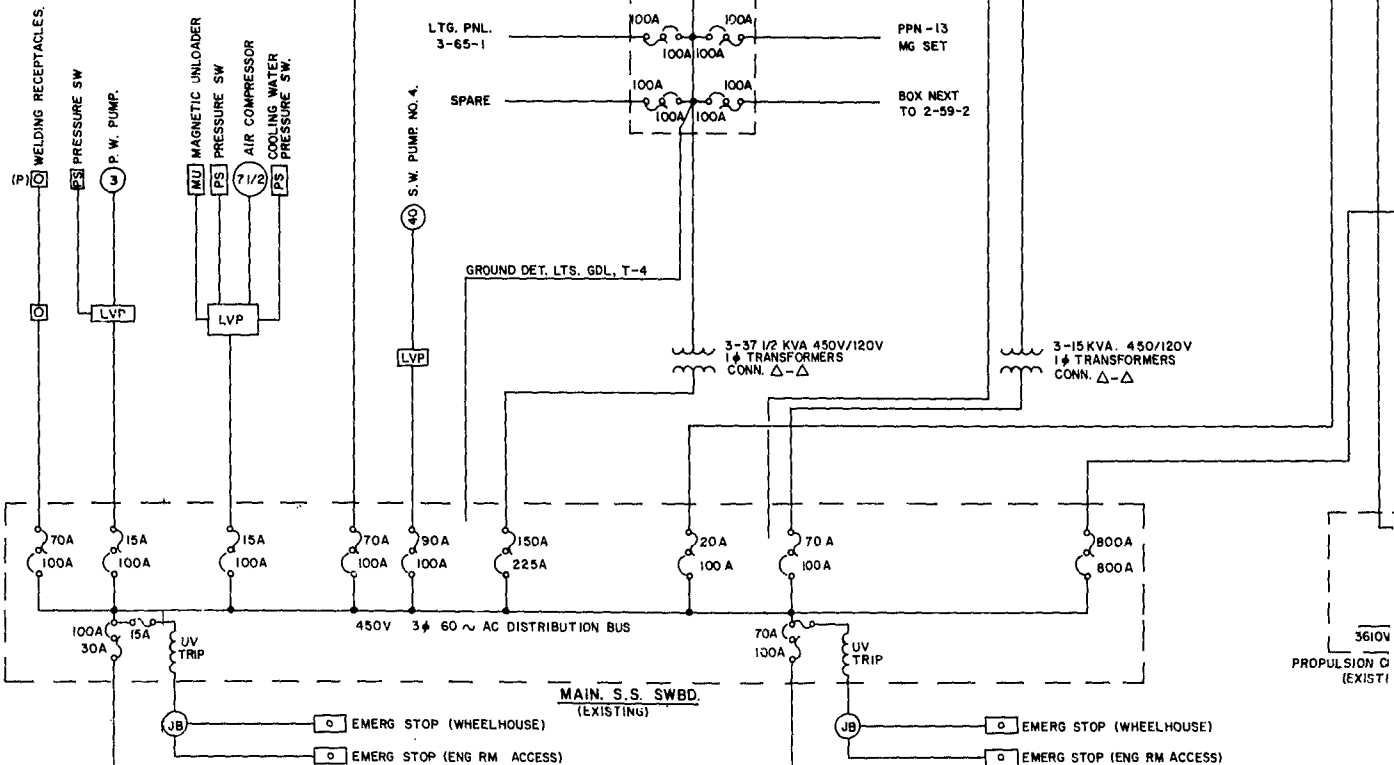
TER SW

KE

PPING WINCH

SUPPLY (FOR HTRS)

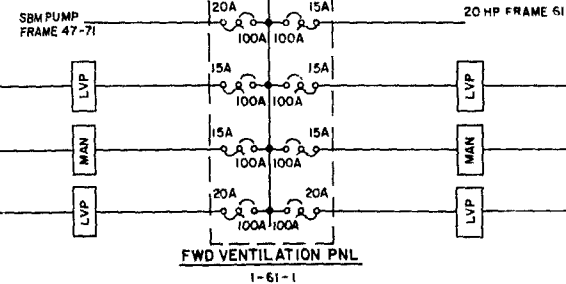
4-51-1



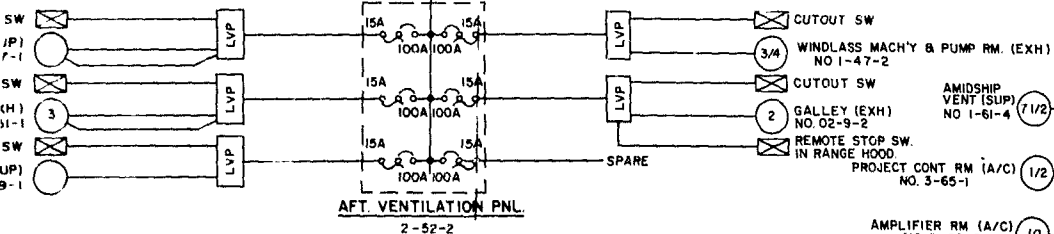
3610V
PROPULSION O
(EXIST)

MAIN. S.S. SWBD.
(EXISTING)

EMERG STOP (WHEELHOUSE)
EMERG STOP (ENG RM ACCESS)



AFT VENTILATION PNL.
2-52-2



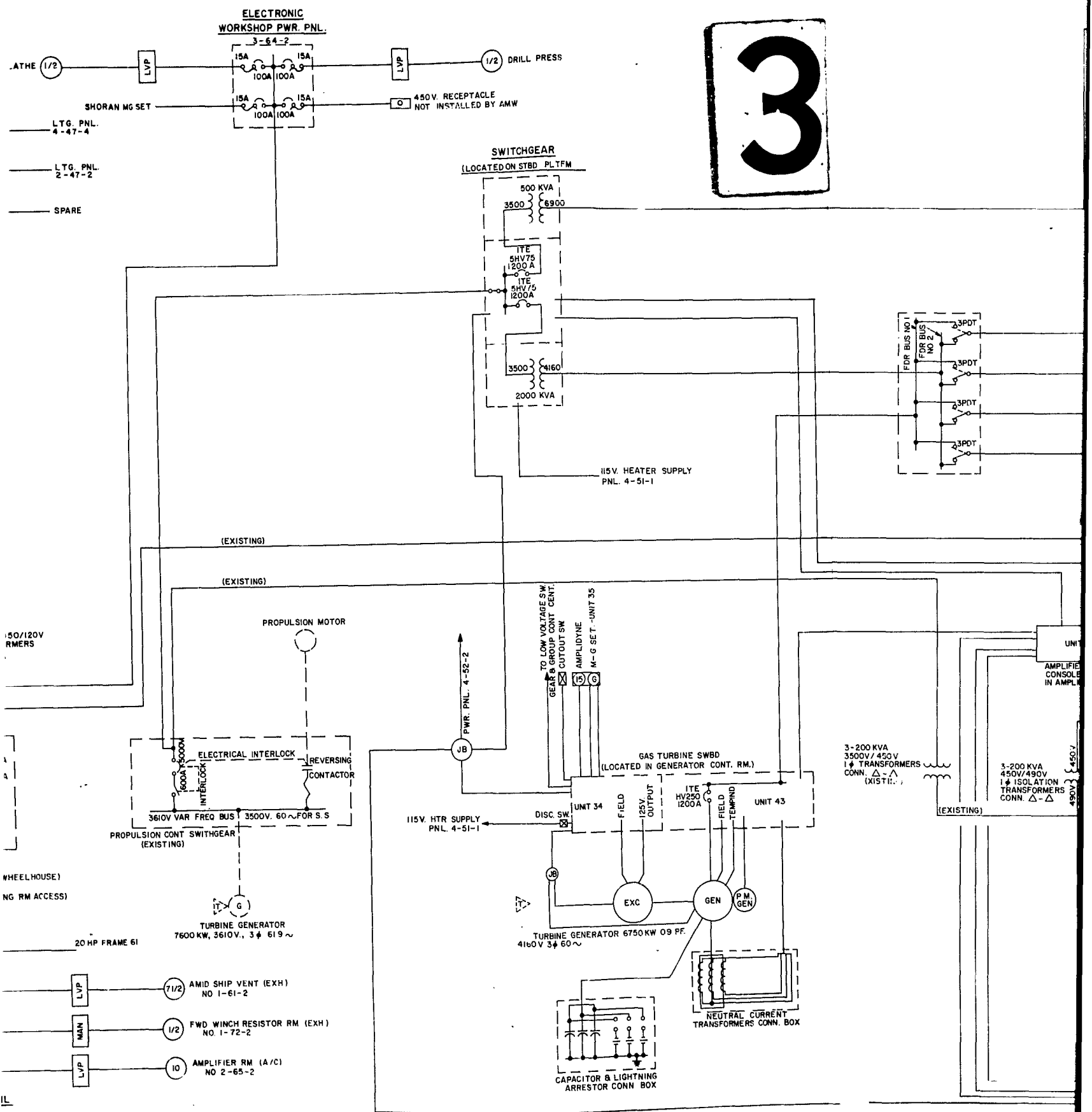
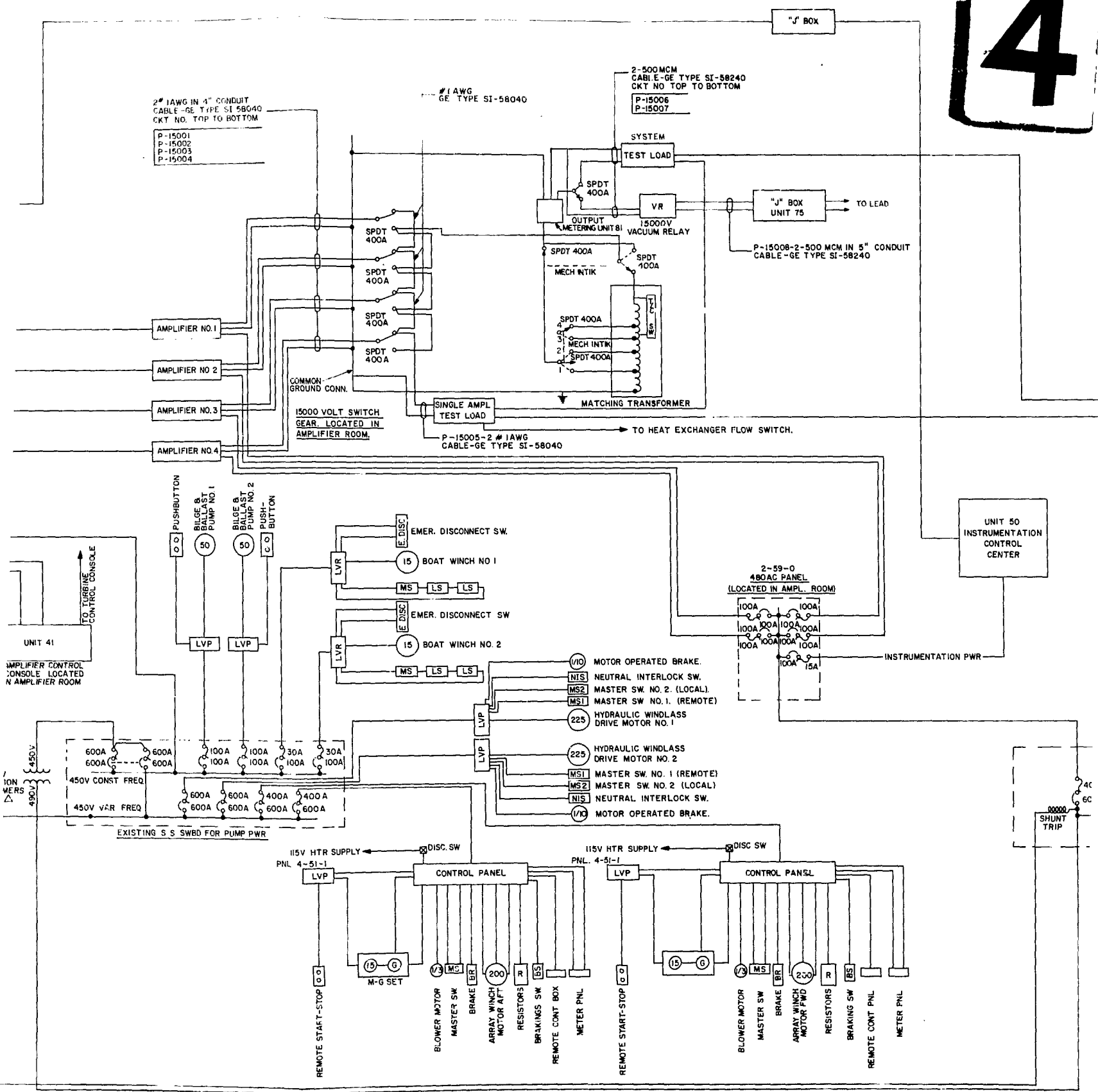
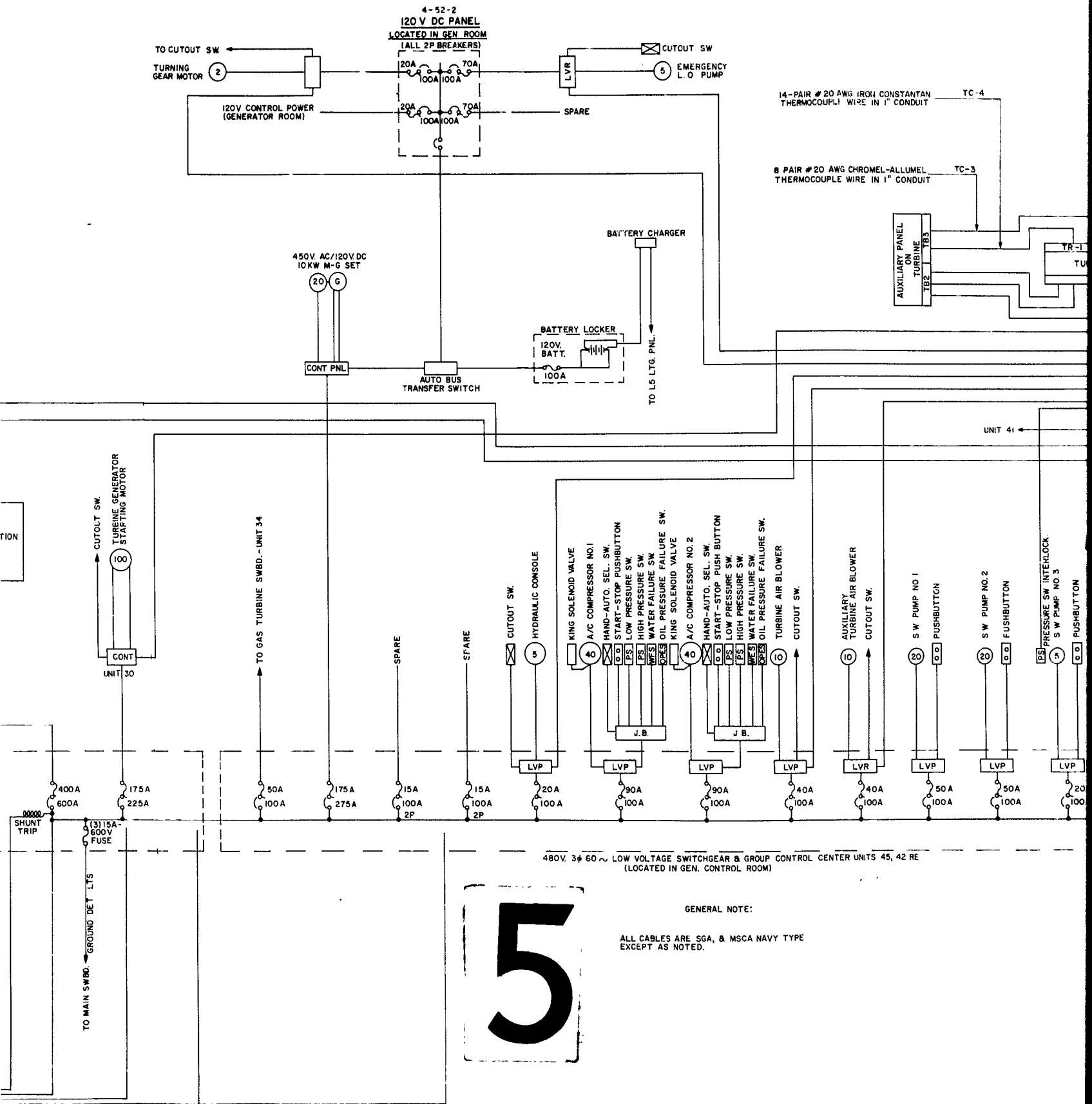
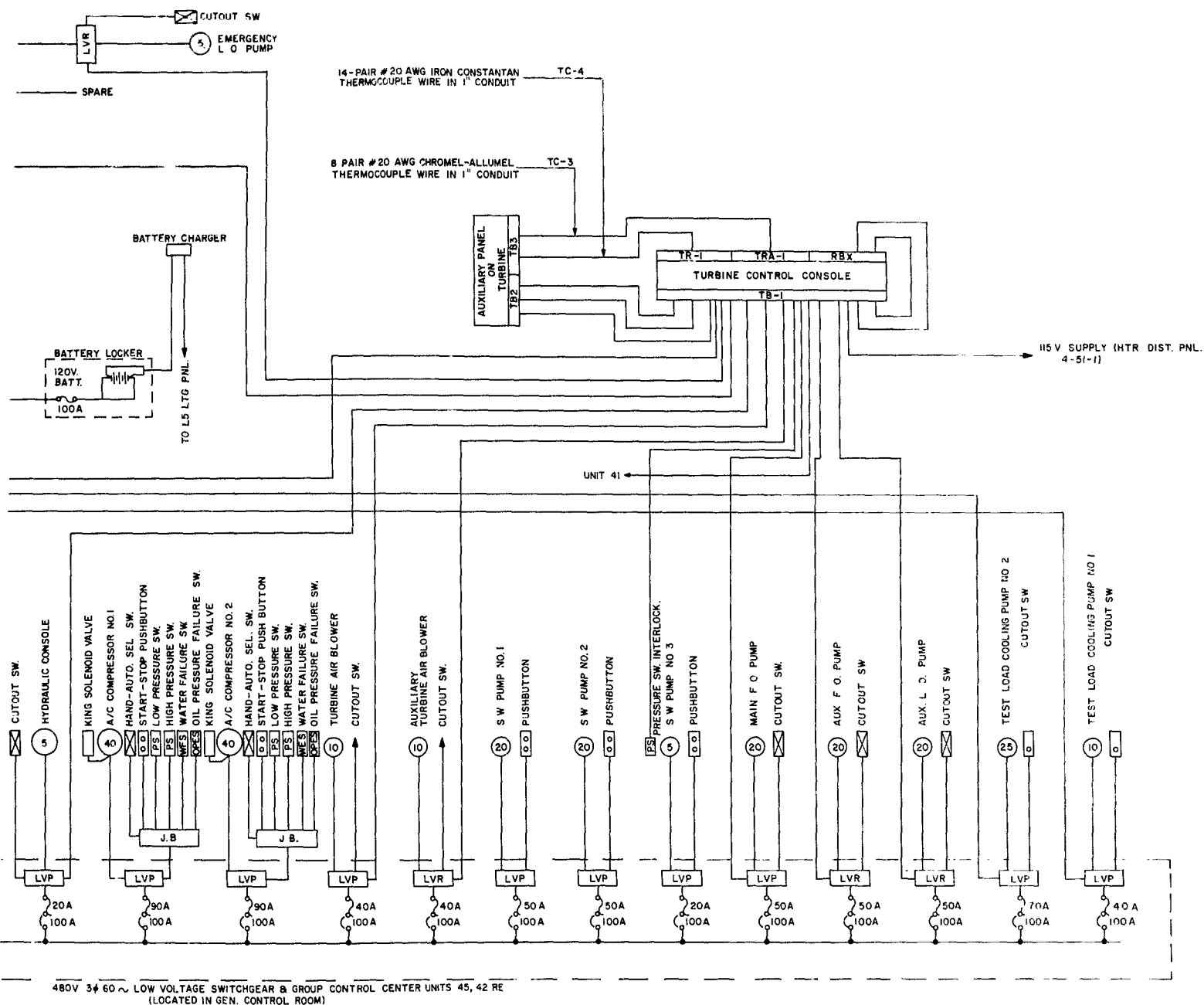


Fig. 22 - Schematic diagram interconnections of componen



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GENERAL NOTE:

ALL CABLES ARE SGA, & MSCA NAVY TYPE
EXCEPT AS NOTED.

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1. Ship's service switchboard for pump power

The power lines proceed here via three 200 kva, 3500/450 volt, single phase transformers connected delta to delta.

2. The 3500 volt switchgear station

This equipment is located on the starboard side of the generator room as illustrated in figure 23 and 24. It is connected via a catwalk to the generator control room. The power lines proceed here via a 1200 ampere disconnect link at the switchgear, unit 44, to the 3500 volt distribution bus. From this bus, this supply is available through an ITE 5HV75, 1200 ampere breaker, the 3500/6500 volt transformer, unit 47, rated at 500 kva to be for the polarizing power. Also, from this bus and through an identical ITE breaker 5HV75, 1200 ampere, the supply comes to the 2000 kva, 3500/4160 volt transformer, unit 46. These various items are identified on figure 24. From this transformer it proceeds to the bus selector switch station, the 4160 volt selector switch located in the amplifier room, where it is referred to as the bus number two to serve as an input to any amplifier. A view of these manually operated switches, units 51-54, are shown in figure 25.

Ship's Service System

The three electrical outputs available from the electrical generators driven by the two steam auxiliary turbines are distributed for general ship's service requirements, ac and dc, and for generator excitation.

The two 450 volt, three phase, 60 cycle generators are each separately connected to the constant frequency bus by an 800 ampere circuit breaker and disconnect switches. Each of the two 120 volt dc generators for ship's service is brought to a switch where either one or the other output can be selected to energize the 120 volt dc distribution bus. Similarly each of the two 120 volt dc generators for propulsion generator excitation is brought to another switch where either one or the other can be selected to energize the 120 volt excitation bus.

The distribution panels and loads off the constant frequency 450 volt (frame size, trip rating, respectively) bus are:



Fig. 23 - Generator room looking forward
a 22-foot 6-inch level

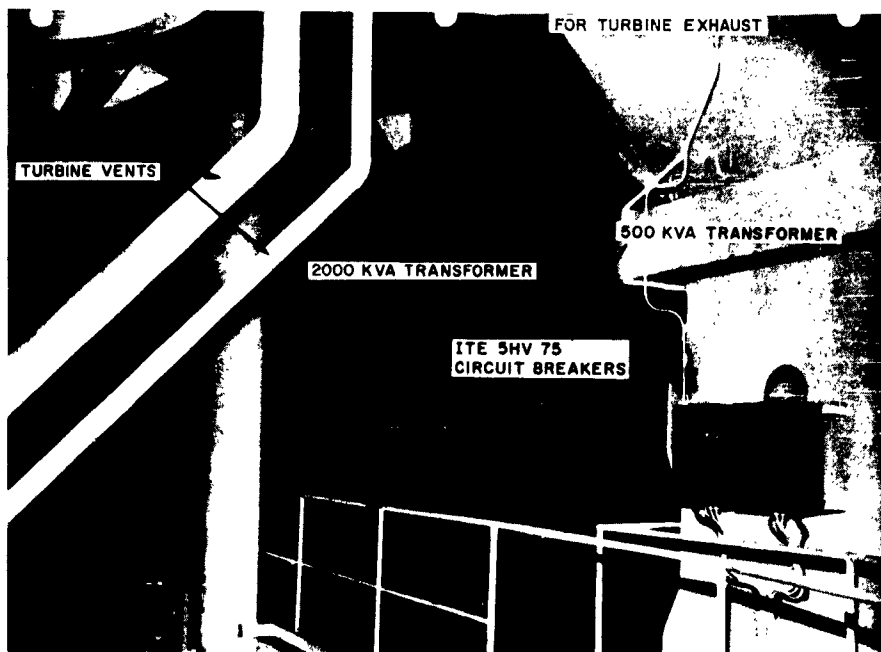


Fig. 24 - Generator room starboard platform

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Fig. 25 - 4160 volt switches for selection of feeder bus No. 1 or No. 2

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1. Aft ventilation panel 2-52-2, 100A-30A,
2. Forward ventilation panel 1-61-1, 100A-70A,
3. Two emergency stop; wheelhouse ,
4. Two emergency stop; engine room access ,
5. Welding receptacles,
FR 45-1/2 main deck and
FR 64 main deck,
6. PW pump - 3 hp, 100A-15A, (Potable water)
7. Air compressor - 7-1/2 hp, 100A-15A,
8. Galley power panel 01-16-1, 100A-70A,
9. SW pump 40 hp, 100A-90A, (Salt water)
10. Three 37-1/2 kva, 450/120 volt, single phase transformers, delta-delta, 225A-150A - forward lighting panel load center panel 2-59-1,
11. Three 15 kva, 450/120 volt, single phase transformers delta-delta, 100A-70A, power for the lighting load, center panel generator room 4-47-(6),
12. Distribution to existing ship's service switchboard for pump power 800A-800A, and
13. Electronic workshop power panel, 3-64-2, 100A-20A.

The specific loads and lines on the distribution panels listed above are as follows:

1. Aft ventilation panel, 2-52-2
Generator room supply, 5 hp
Generator room exhaust, 3 hp
Galley supply, 1 hp
Galley supply, 2 hp
Windlass machinery and pump room, 3/4 hp
One spare

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2. Forward ventilation panel, 1-61-1

Amidships ventilation supply, 7-1/2 hp
Amidships ventilation exhaust, 7-1/2 hp
Project control room (ac), 1/2 hp
Amplifier room (ac), 10 hp
Amplifier room (ac), 10 hp
Forward winch resistor room, 1/2 hp
Submersible pump outlets, frame 47 and 71
Frame 61, 20 hp

3. Galley power panel, 01-16-1

Bake oven, 18 kw
Coffee urn, 5 kw
Mixer, 1 hp
Fry kettle, 12 kw
Dishwasher, 1 hp
One spare

4. Lighting load center panel forward, 2-59-1 (figure 26)

Lighting panel, 1-62-1, 100A-100A
Lighting panel, 3-65-1, 100A-100A
Lighting panel, 2-59-2, 100A-100A
400 cycle motor generator set
Box next to 2-59-2
One spare

5. Lighting load center panel generator room, 4-47-(6)

Heater distribution panel, 4-51-1, 100A-90A
Lighting panel, 4-53-1, 100A-40A
Lighting panel, 4-47-4, 100A-40A
Lighting panel, 2-47-2, 100A-40A
Two spares

6. Electronic workshop power panel, 3-64-2

Lathe, 1/2 hp, 100A-15A
Drill press, 1/2 hp, 100A-15A
450 volt receptacle, 100A-15A
Shoran motor generator set

The existing ship's service switchboard for pump power has several circuits and loads consisting of:

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1. Mechanical interlock, circuit breakers, 600A-600A, to select either 450 volt, constant frequency, or variable frequency bus for group control center, via three 200 kva 450/490 single phase transformers delta-delta (figure 27),
2. Bilge and ballast pump number 1, 50 hp, 100A-100A,
3. Bilge and ballast pump number 2, 50 hp, 100A-100A,
4. Boat winch number 1, 15 hp, 100A-30A,
5. Boat winch number 2, 15 hp, 100A-30A,
6. Hydraulic windlass number 1, 225 hp, 600A-600A, and 1/10 hp motor operated brake,
7. Hydraulic windlass number 2, 225 hp, 600A-600A, and 1/10 hp motor operated brake,
8. Array winch motor forward, 200 hp, 600A-400A, and 15 hp motor generator set and 1/3 hp blower, and
9. Array winch motor aft, 200 hp, 600A-400A, and 15 hp motor generator set and 1/3 hp blower.

The specific loads of the group control center (figure 28) listed above are as follows:

1. Feeder breaker, 600A-400A, for unit 48, located within unit 45
2. Feeder breaker, 225A-175A, within unit 45 for turbine starting motor, 100 hp
3. Amplidyne set via unit 34 (unit 35)
4. 10 kilowatt ac/dc motor generator set, 20 hp, 100A-40A
5. Four spares, 100A-15A
6. Leads - RCS
 - a. Number 5 - amplifier control console
 - b. Number 4 - amplifier control console
 - c. Number 7 - test load - single
 - d. Number 8 - test load - multiple
7. Hydraulic control, 5 hp, 100A-20A
8. Air conditioner number 1, 40 hp, 100A-90A
9. Air conditioner number 2, 40 hp, 100A-90A
10. Turbine air blower, 10 hp, 100A-40A

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Fig. 26 - Power panels on aft bulkhead, frame 59,
of amplifier room

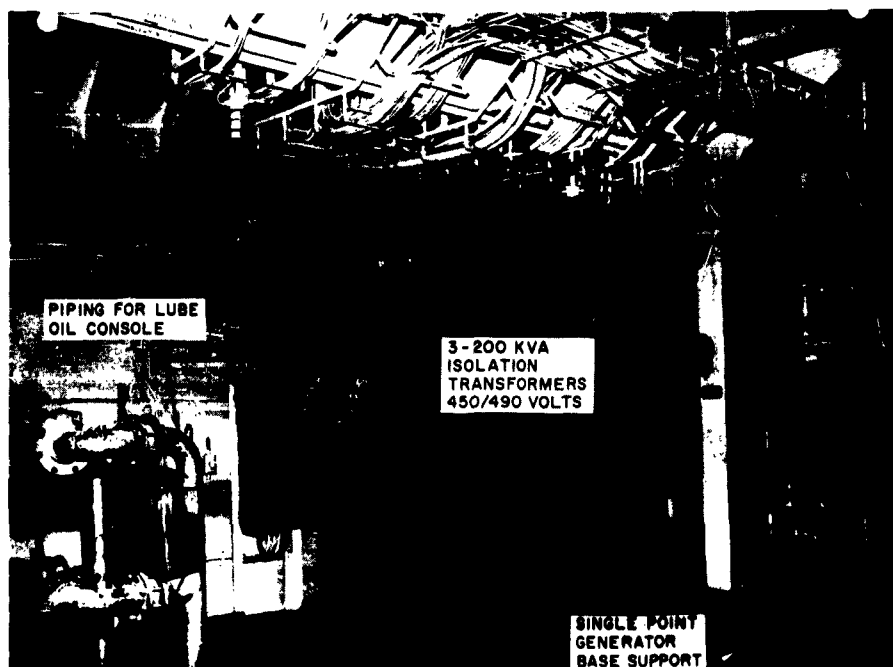


Fig. 27 - Generator room looking portside forward

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Fig. 28 - Switchgear in generator control room

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11. Auxiliary turbine air blower, 10 hp, 100A-40A
12. Salt water pump number 1, 20 hp, 100A-50A
13. Salt water pump number 2, 20 hp, 100A-50A
14. Salt water pump number 3, 5 hp, 100A-20A
15. Main fuel oil pump, 20 hp, 100A-50A
16. Auxiliary fuel oil pump, 20 hp, 100A-50A
17. Auxiliary lube oil pump, 20 hp, 100A-50A
18. Test load cooling pump number 1, 100A-40A
19. Test load cooling pump number 2, 100A-40A

The 480 volt ac panel (unit 48) 2-59-0, listed above, has five major loads. These are:

1. Amplifier number 1, 100A-100A,
2. Amplifier number 2, 100A-100A,
3. Amplifier number 3, 100A-100A,
4. Amplifier number 4, 100A-100A, and
5. Instrumentation power, 100A-15A.

Gas Turbine-Generator System

The output of 8000 kva generator is brought to an ITE 5HV250-1200A circuit breaker (unit 43) located in an elevated platform on the port side of the generator room. From here this output continues to the bus selector switch station, the 4160 switchgear in the amplifier room, where it is referred to as feeder bus number one. This bus is connected through disconnect switches to each of the four amplifiers where it is subsequently rectified and used for the plate supply power.

Auxiliaries

There are three other distribution systems which are associated with the project equipment operation or support. These consist of a 500 kilowatt diesel generator, circuit breaker control and emergency power and a 60 kilowatt diesel generator.

The output of the 500 kilowatt, 240 volt dc diesel generator is connected to the 230 volt dc load center panel 4-51-1. This panel has the following loads:

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One topping winch, 50 hp, 225A,
Two ranging winches, 20 hp, 100A-100A,
Six mooring winches, 50 hp, 400A-300A, and
One hoist winch, 50 hp, 225A-225A.

The circuit breaker control and emergency power requirements are obtained by an automatic bus transfer switch rated at 100A from either a 120 volt dc, 10 kilowatt motor generator set or from a 120 volt dc battery locker. The charger for this battery is operated from the L5 lighting panel. The line from the automatic transfer switch goes to the 120 volt dc panel 4-52-2 (unit 49) which has circuits for the:

Turning gear motor, 2 hp, 100A-20A,
Emergency lube oil pump, 5 hp, 100A-70A,
120 volt control power, 100A-20A, and
One spare.

The sixty kilowatt diesel generator and the associated distribution system are a temporary installation intended to be used only until the transducer array is completed. The distribution system connects the output of this sixty kilowatt dc generator to the coaxial power cable via a special connection in the amplifier room.

Amplifiers and Control

The ARTEMIS source transducer is energized by four electronic amplifiers. Provisions are made for paralleling their outputs to the transducer in any combination. Each amplifier can deliver 1300 kilowatts of power into a matched load having a power factor of 0.9 or greater. This is applicable over the frequency range of 90 to 1800 cps. A single matching transformer and suitable switching arrangement permits connecting one, two, three or four amplifiers to the transducer. Amplifiers can also be switched to a test load for purposes of maintenance and tests. Control of the amplifier modules can be effected either from the individual modules or from a central control console. Plate power for the amplifier is obtained from a gas turbine generator previously described. The plate power for any one amplifier can be supplied from the ship's propulsion generator. The input signal is derived from the master programmer through the amplifier control console. An auxiliary signal source is also available in the console for test purposes.

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The four amplifiers, control console, high voltage switches, matching transformer and test loads are located in the amplifier compartment as shown in figure 29. Figures 30 and 31 show amplifiers three and one respectively. A block diagram of the electrical interconnections is shown in figure 32. Each amplifier is contained in six metal cubicles which are arranged fore and aft in the center of the compartment facing the center aisle. The control console, master programmer and instrumentation racks are aligned along the port bulkhead; while the high voltage switches, test loads, and matching transformer are located on the starboard side behind expanded metal screening. Figures 33, 34, 35 and 36 show the amplifier control console, high voltage switches, matching transformer and test loads respectively. Figure 37 is a rear view of one of the test loads. Access doors to the screened area and rear doors of the amplifier cubicles are electrically interlocked for personnel protection. The screened area (figure 38) contains the high voltage switches, test loads and matching transformer.

Two water-cooled test loads are provided; a 1300 kilowatt load which can accommodate a single amplifier and a 5200 kilowatt load which can be matched to one, two, three or four parallel amplifiers. Matching of the test load or transducer load to one, two, three or four amplifiers is accomplished by means of a single matching transformer with a suitable number of taps. The entire system is grounded to the ship at one point near the matching transformer.

The output stages of the amplifier modules are cooled by self-contained fresh water systems. Heat exchange is accomplished via externally supplied salt water.

Master Programmer

The master programmer (units 84 and 85) controls the transmissions of the ARTEMIS source. The equipment consists of two racks of electronic instrumentation located adjacent to the amplifier control console in the amplifier compartment.

A precision chronometer, synchronized with WWV transmissions, provides digital control for a sequence of adjustable time intervals. Signal sources are provided as an integral part of the programmer. Supplementary functions such as real time display, event time read-out, valve control signals for gas turbine primary power source, and pre-pulses for instrumentation sub-programming, are also provided.

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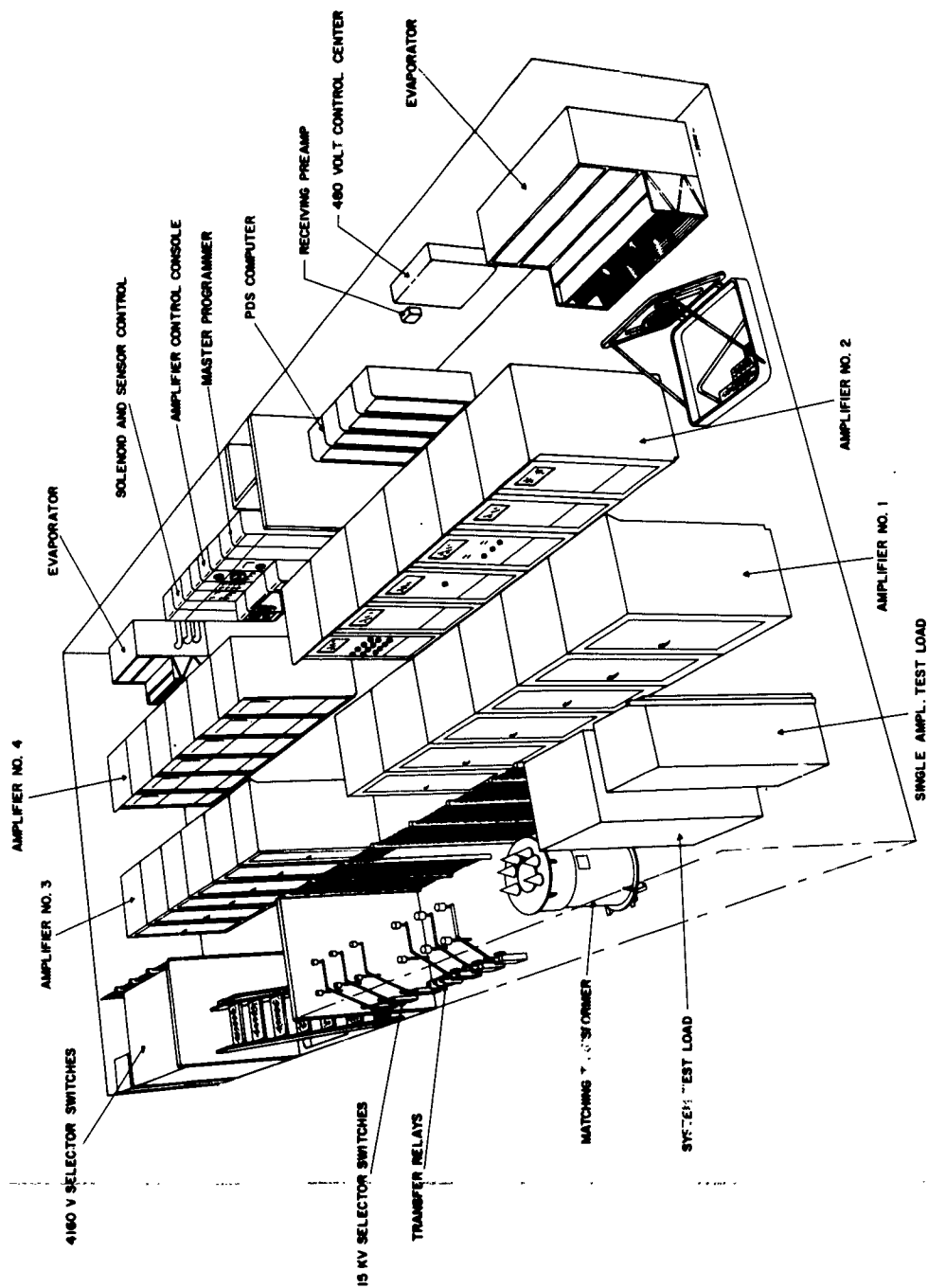


Fig. 29 - Amplifier room

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Fig. 30 - Amplifier assembly No. 39



Fig. 31 - Amplifier assembly No. 40

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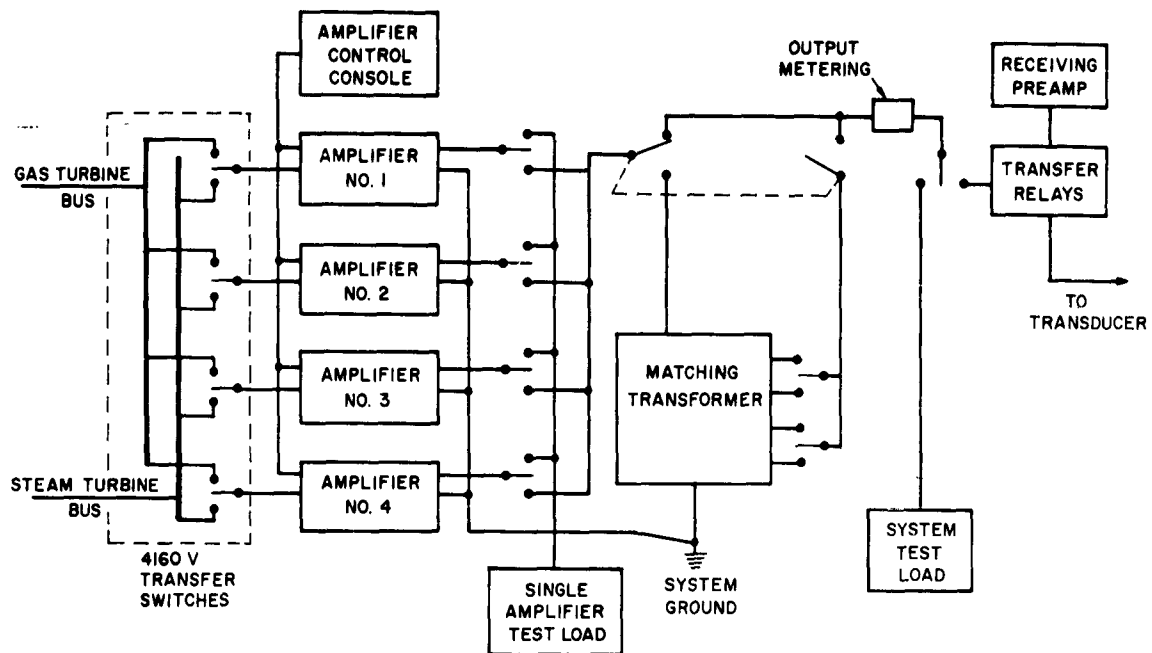


Fig. 32 - Power station interconnections



Fig. 33 - Amplifier control console

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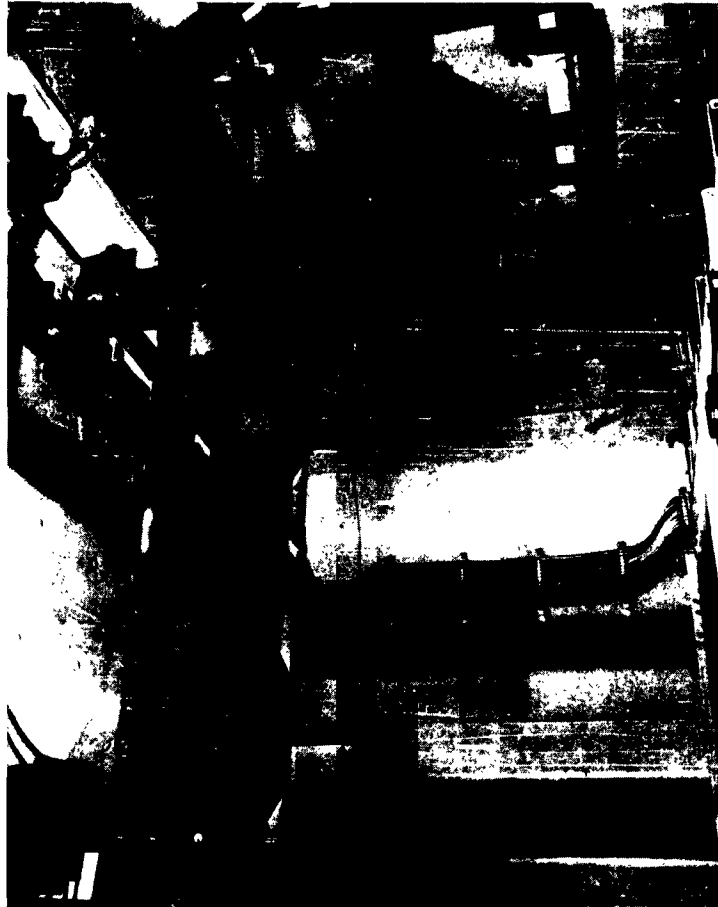


Fig. 34 - 15-kv selector switches

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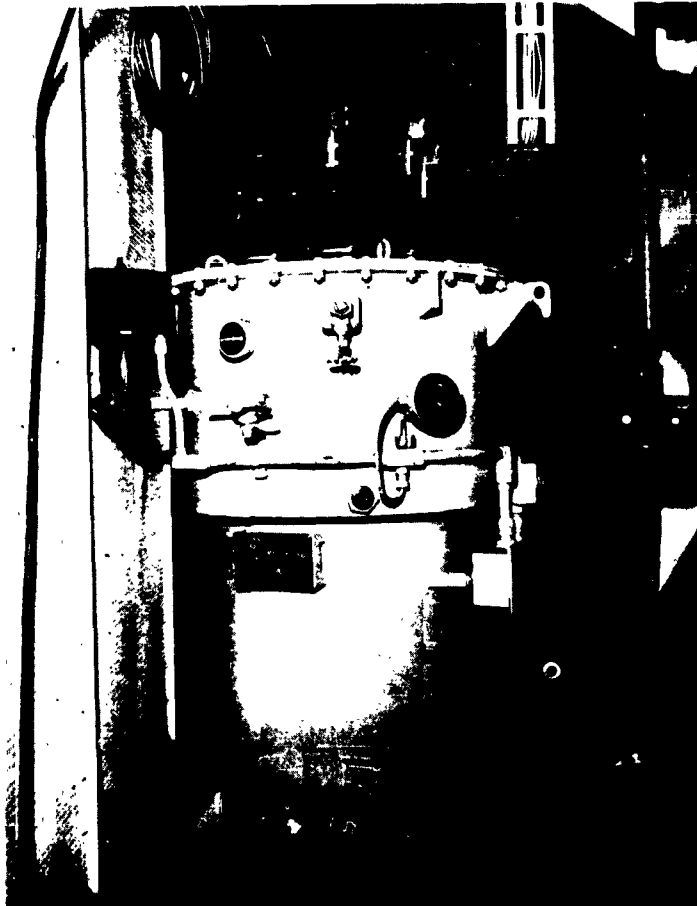


Fig. 35 - Load matching transformer

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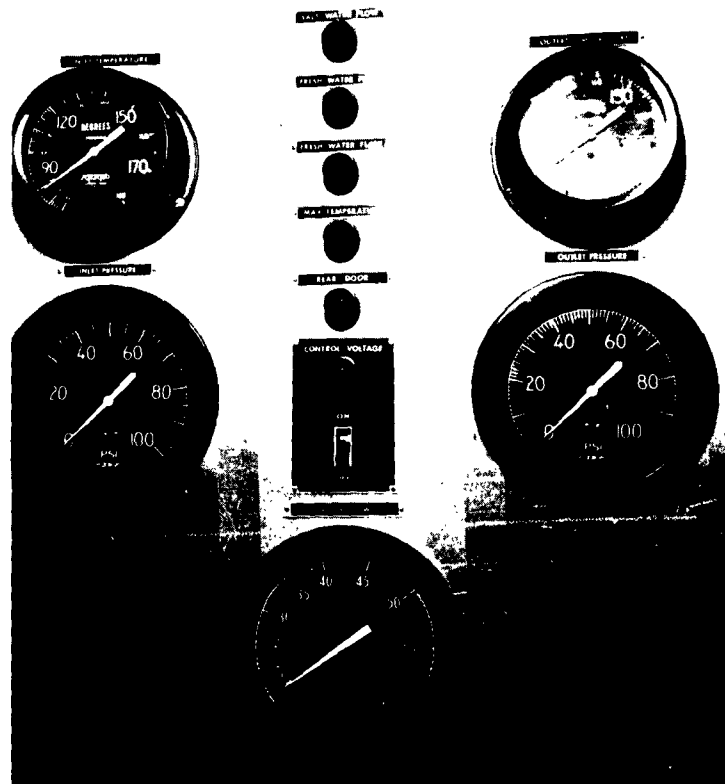


Fig. 36 - Front panel - 52 megawatt test load

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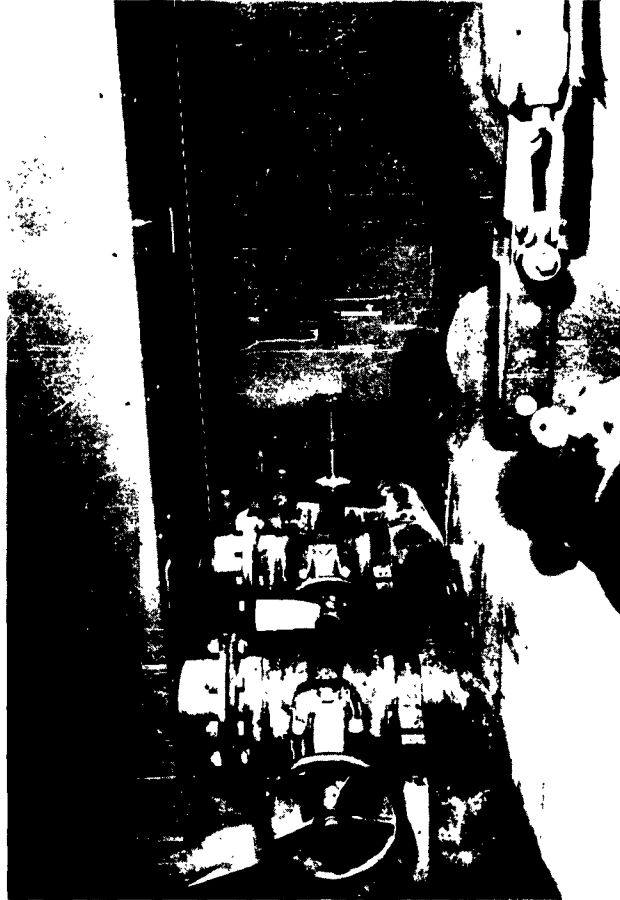


Fig. 37 - Rear view - 5.2 megawatt test load

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Fig. 38 - High voltage screened area - amplifier compartment

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A front view of the programmer is illustrated in figures 39 and 40. Figure 41 shows the installation in the ship adjacent to the amplifier control console. Figure 42 is an in-line time diagram of the major parameters in the programmer timing sequence. The following description summarizes the function of each of the timed events. A block diagram for reference is shown in figure 43.

Signal Gate

The programmer provides a gated signal output which is applied to the source transducer through the power amplifier. The signal period, or pulse length, can be varied from 0.01 to 99 seconds or switched to continuous output. A choice of signal sources is available. A push button oscillator constitutes a stable cw source with frequency adjustable in 1/2 cps increments. A built-in frequency meter measures and displays the oscillator frequency at all times. Alternately, a noise source is available. Either signal source can be switched into the input of the gate and is subsequently passed through a 350-450 cps band-pass filter and an amplitude limiter. An interlock circuit prevents the gate from opening if the transducer transfer switches fail to operate properly or if the gas turbine is not prepared for the application of the load.

Prepulse

The prepulse can be set to occur zero to ninety seconds prior to the signal output in ten-second increments. Its function is that of programming auxiliary monitoring instrumentation.

Key Pulse

The key pulse occurs coincident with the beginning of the signal output. It is also used in the programming of auxiliary monitoring instrumentation.

Post Key Pulse

The post key pulse occurs twenty-five milliseconds after the key pulse and initiates read-out of the transducer current sensors.

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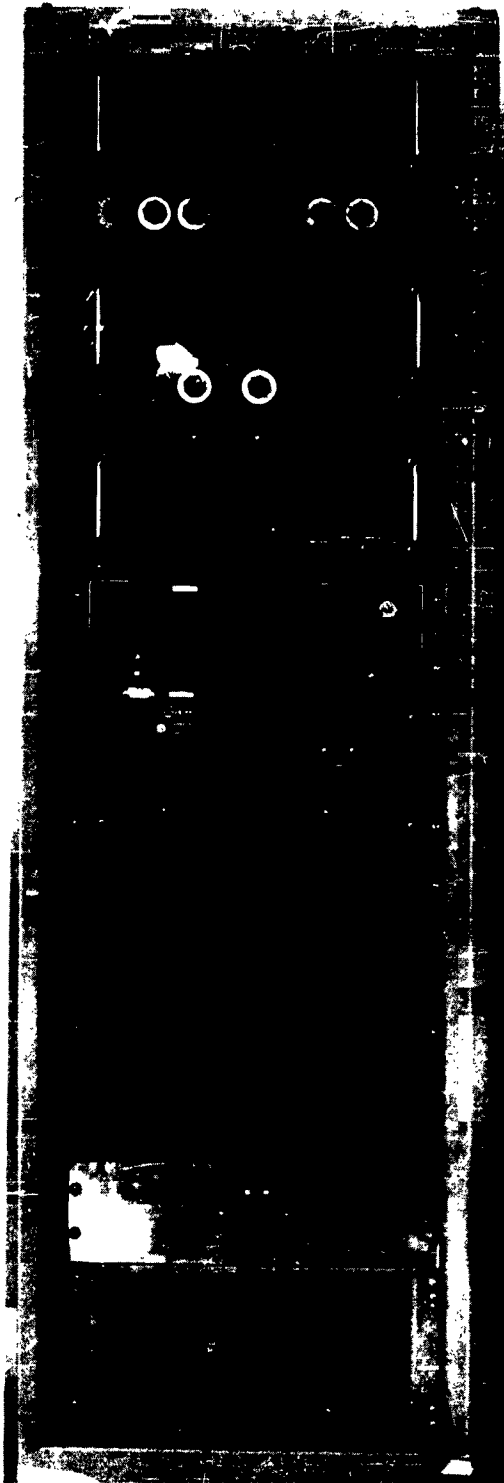


Fig. 39 - Master programmer -
programming unit

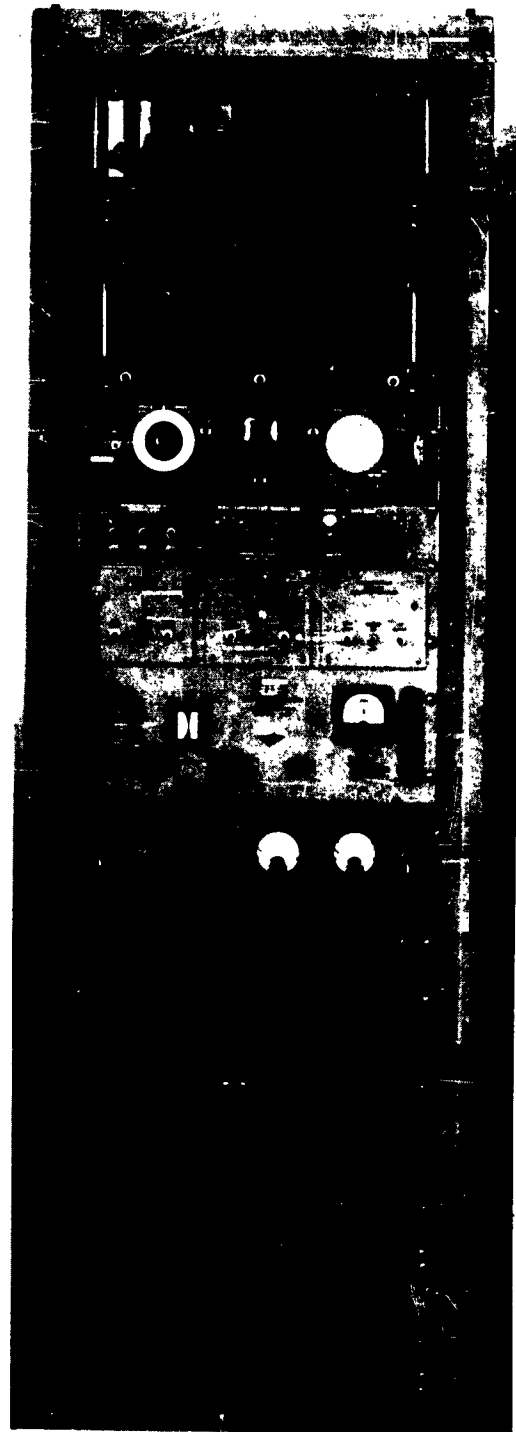


Fig. 40 - Master programmer -
timing unit

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Figure 41

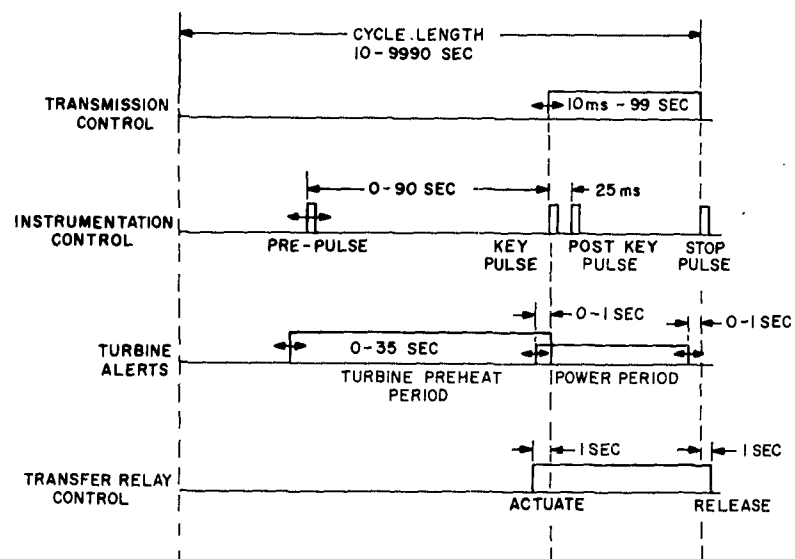


Figure 42

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Stop Pulse

This pulse occurs at the end of the signal period and initiates sensor read-out.

Turbine Alerts

The first turbine alert period begins with the closure of a DPDT relay. The relay can be set to close zero to thirty-five seconds before the signal period in one-second increments. The opening of the relay occurs when the second turbine alert relay closes. The second turbine alert relay remains closed for a length of time equal to the length of the signal period. The closure occurs zero to one second, in 0.1-second increments, before the signal period begins. Since this relay remains closed for a period of time equal to the length of the signal period, its opening will precede the end of the signal period by the same margin as the closing preceded the period start. The function of these relays is to alert the turbine to the application and release of the load.

Transfer Control Relay

The transfer control relay provides 110 volt, 60 cycle voltage for closing the transducer transfer relays. The transfer relays are switched to the transmit position from approximately one second before the signal period until approximately one second after.

Time Storage

In addition to the timed outputs, there is a four-line code output of the time storage unit. This unit, on command, stores nine digits, milliseconds through hours, of current time. The storage is effected by both external command and internally by the key pulse. The output permits printing of the time of transmission or other event time if desired.

Real Time Display

There is an in-line display of real time in seconds, minutes, and hours, on the front panel.

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Ping Number

At any desired signal pulse, a pulse count can be initiated. Maximum storage is a count of 999. A four-line binary coded output is available for printing. The printed record of ping number will serve to correlate the data of the position determining computer during signal monitoring tests.

Code Digits

A binary coded output of a preselected number from one to 99 is available for printing for data correlation purposes.

Clock Pulses

Clock pulse outputs at frequencies of one and 1000 pps are available for time synchronization of external equipment.

Instrumentation Monitoring and Control

There are various instrumentations associated with the source for the purpose of monitoring mechanical, electrical and acoustic parameters involved in installation, testing and operation. Circuits are also provided for remote control of the electrical interconnection of transducer elements.

Remote Indication of Orientation of Submerged Units

An instrumentation capsule containing a north-seeking gyro compass, inclinometers and a depth sensor will be used to determine structure orientation on the bottom during installation. It will first be lowered with the array structure to determine orientation of this structure during mobile phases of the operation. If and when the array structure is fixed to the ocean floor as a fixed transducer, the capsules will be used to determine the orientation of the foundation platform, intermediate base and the array structure. Thus, it will be lowered first with the foundation platform, then with the intermediate base and array structure. The capsule will remain on the array structure after installation, although its connecting cable will be laid out on the bottom and marked with a buoy and therefore will not be accessible for measurements. When in use, during the preliminary immersion tests and later during the installation, the capsule will be connected by cable to sensor readouts aboard the USNS MISSION CAPISTRANO.

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The gyro compass will measure bearing with an accuracy of ± 1 degree with respect to a pre-set heading. This is an Arma subminiature gyro with all transistorized electronic circuit.

There are two sets of pendulus inclinometers. One set measures level and cross level up to ± 10 degrees with an accuracy of ± 0.1 degrees. The other set also measures level and cross level but reads to ± 70 degrees with an accuracy of 1.75 degrees.

A pressure type depth sensor will measure capsule depth with an accuracy of ± 3 feet.

The outputs of all the instruments in the instrumentation capsule are dc voltages and will be read by vacuum tube voltmeters at the control station. One set of read-outs will be mounted in an instrumentation rack in the control station and a duplicate set will be displayed at the array winch control position. A digital vacuum tube voltmeter will provide for high accuracy measurements of the sensor outputs.

Current Sensors

The dc polarizing currents and the ac drive currents for the transducer modules are measured by current sensors located in the component tanks in the array structure. There are two dc sensors in each of the four component tanks. The second sensor in each tank serves as a spare. Each tank also contains ten ac sensors, two for each transducer module. Here again, the second sensor is a spare. The sensors are sampled automatically during each transmission. There are two stepping switches in each tank, one active and one spare. These sample the sensor outputs and select those sensors to be sampled. The sensor information is transmitted via the instrumentation cable to the source ship where it is automatically printed along with the time of each transmission and coding to identify which of the sensors is being sampled. The sensor read-outs are located in the amplifier compartment in the instrumentation sensor rack, unit 71. Figure 44 shows a close-up view of the sensor sampling rack.

Remote Control of Transducer Module Connections

The 1440 source elements are grouped in twenty six-by-twelve element modules. The modules are connected, in groups of five, into the four

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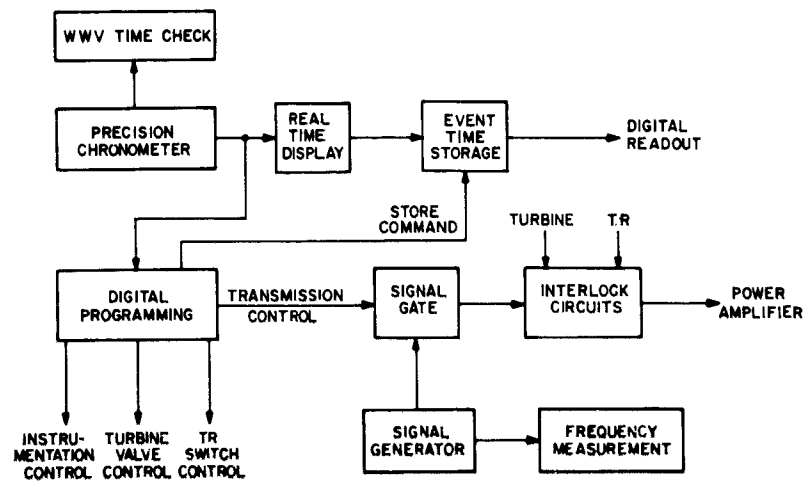


Fig. 43 - Master programmer for Project Artemis acoustic source

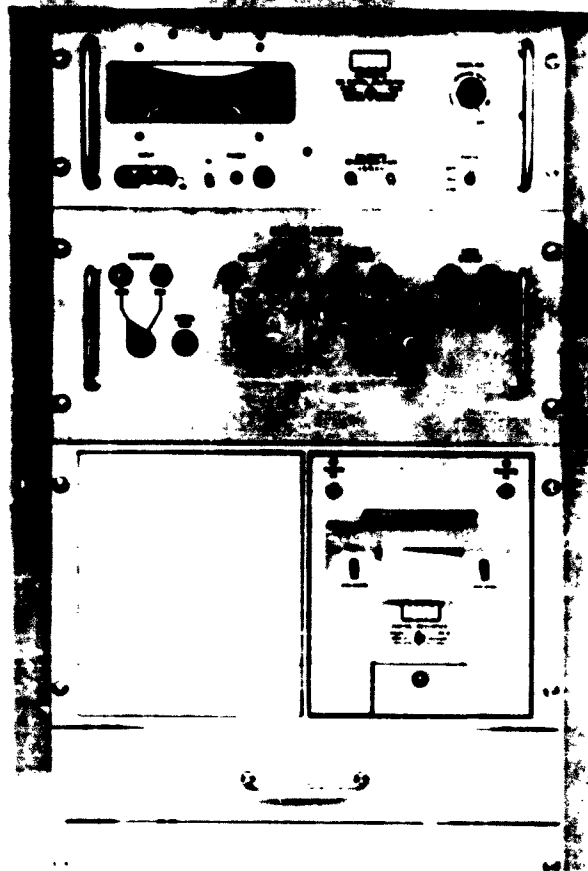


Fig. 44 - Sensor sampling rock

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component tanks. Figure 45 illustrates the interconnections of the modules in a component tank and figure 46 shows the connection of component tanks into the junction box.

In order to prevent a casualty in one module group from disabling the entire transducer, remotely controlled contactors are provided which will permit the isolation of the defective group. The contactors are located in the submerged junction box directly in front of the component tanks on the array structure. They are remotely controlled from manually operated switches on panel 40R of the amplifier control console.

Acoustic Monitoring and Calibration

Monitoring and calibration of the acoustic source will be accomplished by means of mobile instrumentation installed on an assist ship. A monitoring transducer of the ceramic cylinder type will be lowered from the assist ship by means of an electrically operated winch. A 1/4 inch wire rope will support the weight of the hydrophone whereas electrical connection will be by means of a 0.28 inch diameter, two-conductor, shielded cable which will be married to the wire rope at intervals of 100 feet.

Instrumentation aboard the monitor ship will record the amplitudes of the received acoustic transmissions in both digital and analogue form with logarithmic scales. An FSK radio link between the source station and monitor ship will synchronize monitoring operations with source transmissions. A radio voice channel will also be available. Figure 47 shows a view of the electronic instrumentation associated with the monitor station installed in a portable shelter.

The position of the monitoring hydrophone relative to the source will be measured prior to each source transmission. This measurement will be accomplished by means of the positioning determination system (PDS). The PDS consists of an array of four hydrophones mounted above the source transducer, a coordinate computer located in the amplifier compartment of the source station, an FSK radio link between the source station and monitor ship, and an acoustic beacon at the monitoring hydrophone. A pulse will be transmitted from the master programmer to the monitor ship, via the FSK link, one second before each source transmission. This pulse will initiate a ten kilocycle/

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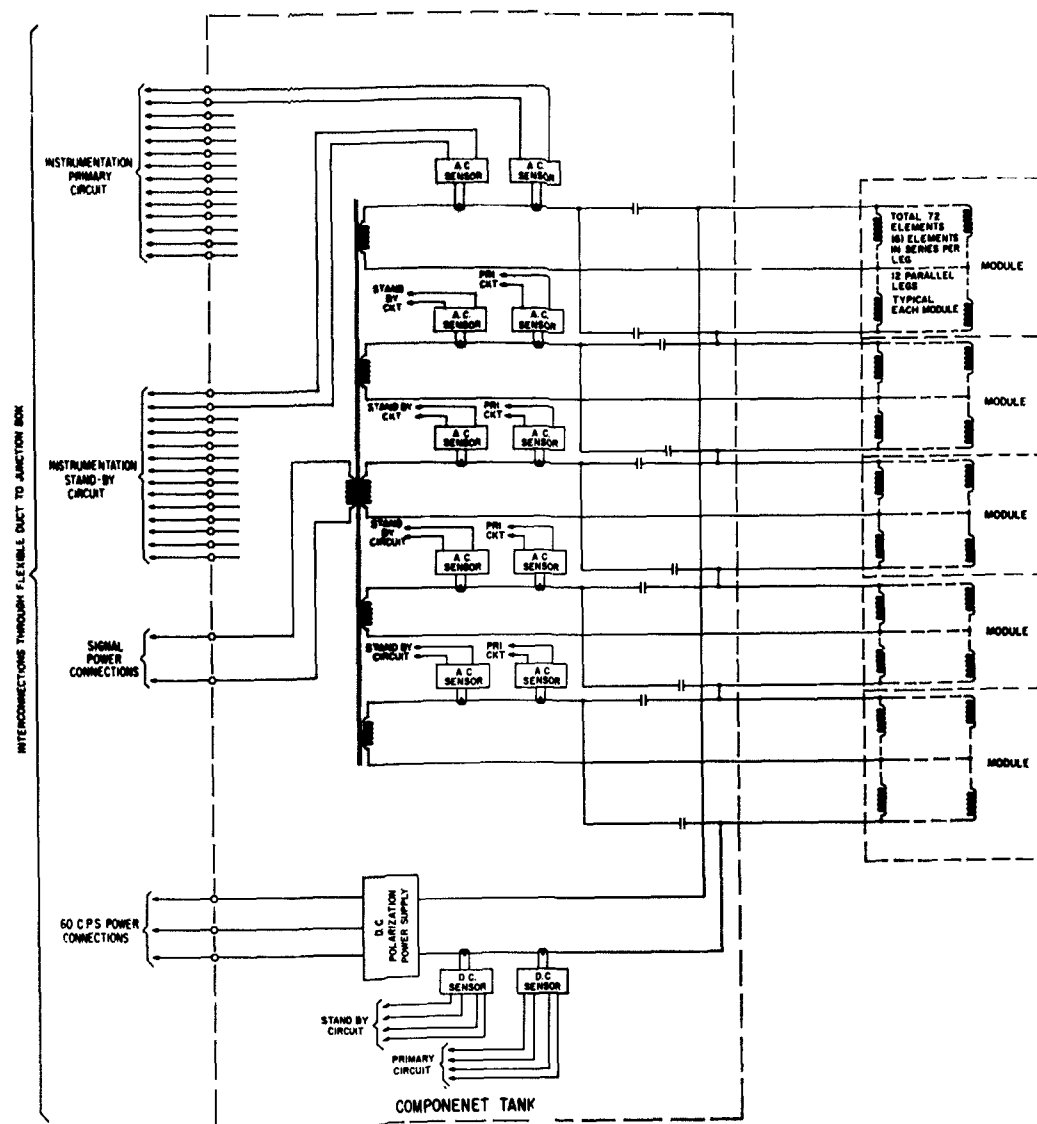


Figure 45

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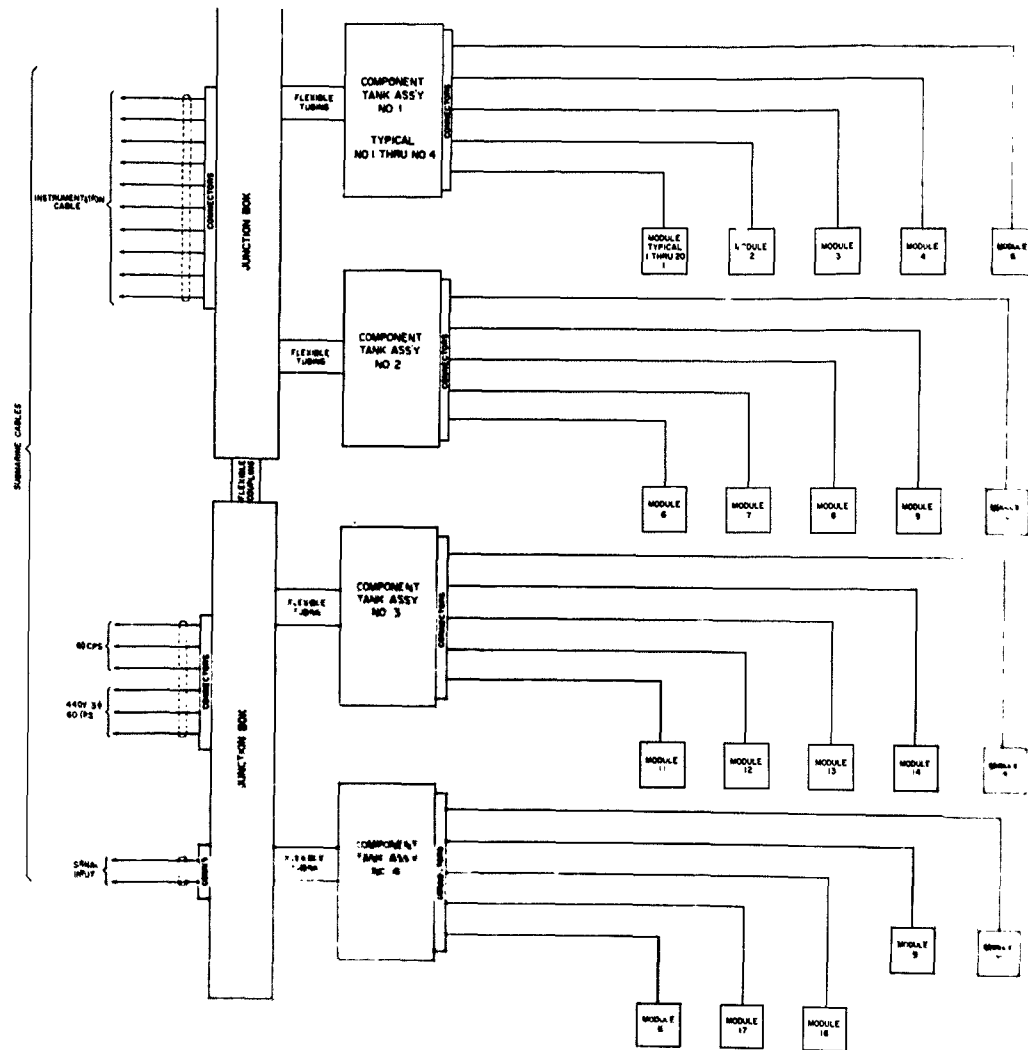


Figure 46

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second transmission from the monitor hydrophone. The relative times of arrival and phases of the ten kilocycle per second transmission, as received with each of the four hydrophones in the PDS array, will be processed by the PDS coordinate computer to yield the direction cosines and range of the monitor hydrophone relative to the PDS array. The quantities will be automatically printed along with time, ping number and identifying code digit. Figure 48 illustrates the configuration of the PDS array and the manner in which the direction cosines are generated. Figure 49 shows the position of the PDS array on the source transducer. The angle, Ω , illustrated in figure 49 is computed from the direction cosines of γ and β and is used to plot the hydrophone position during the monitoring operation as an aid to maneuvering. Figure 50 shows the PDS array and computer during factory tests. A detailed view of the computer is given in figure 51. A block diagram of the monitoring instrumentation is shown in figure 52. It will be noted that, in addition to the instrumentation previously described, the system includes instrumentation for the measurement of range at the monitor ship. This function is accomplished by measuring the propagation time of the 400 cps transmission and is less accurate than the range measurement performed at the source station. Its purpose is to assist in monitor ship maneuvering.

In operation, the monitor ship will maneuver so as to obtain acoustic field measurements in the desired directions relative to the source transducer. Measurements will be made at short range with a maximum range capability of approximately 1000 yards. Hydrophone position data will be plotted concurrently with its acquisition solely for the purpose of indicating the areas in which additional measurements are needed. Final analysis of the data will require the services of a computer to normalize the intensity data to a fixed range, to include calibration factors, and to translate the measured hydrophone positions from the PDS array reference to the source transducer reference.

Transducer Array

The transducer array consists of twenty modules each containing seventy-two transducers mounted on a structure to form a closely packed planar array. Within the framework of the structure are mounted several supplementary systems comprising the sonar system.

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Fig. 47 - Monitoring instrumentation shelter

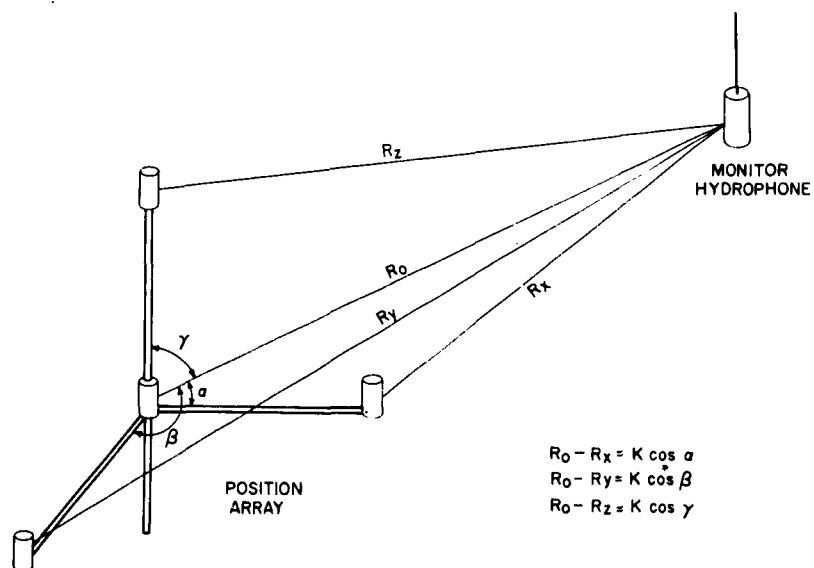


Fig. 48 - Monitor hydrophone position measurement

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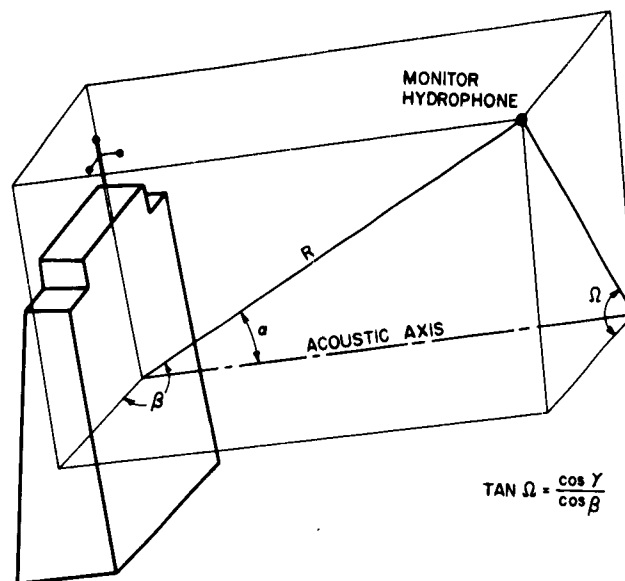


Fig. 49 - Locating monitor hydrophone with respect to acoustic axis of the source



Fig. 50 - Computer and hydrophone array

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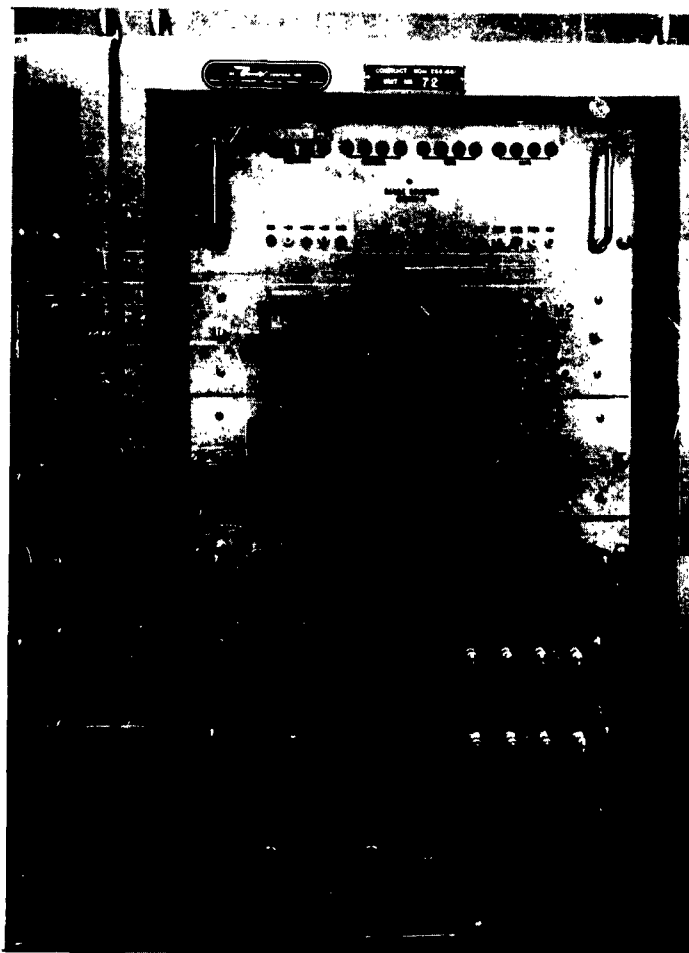


Fig. 51 - PDS coordinate computer

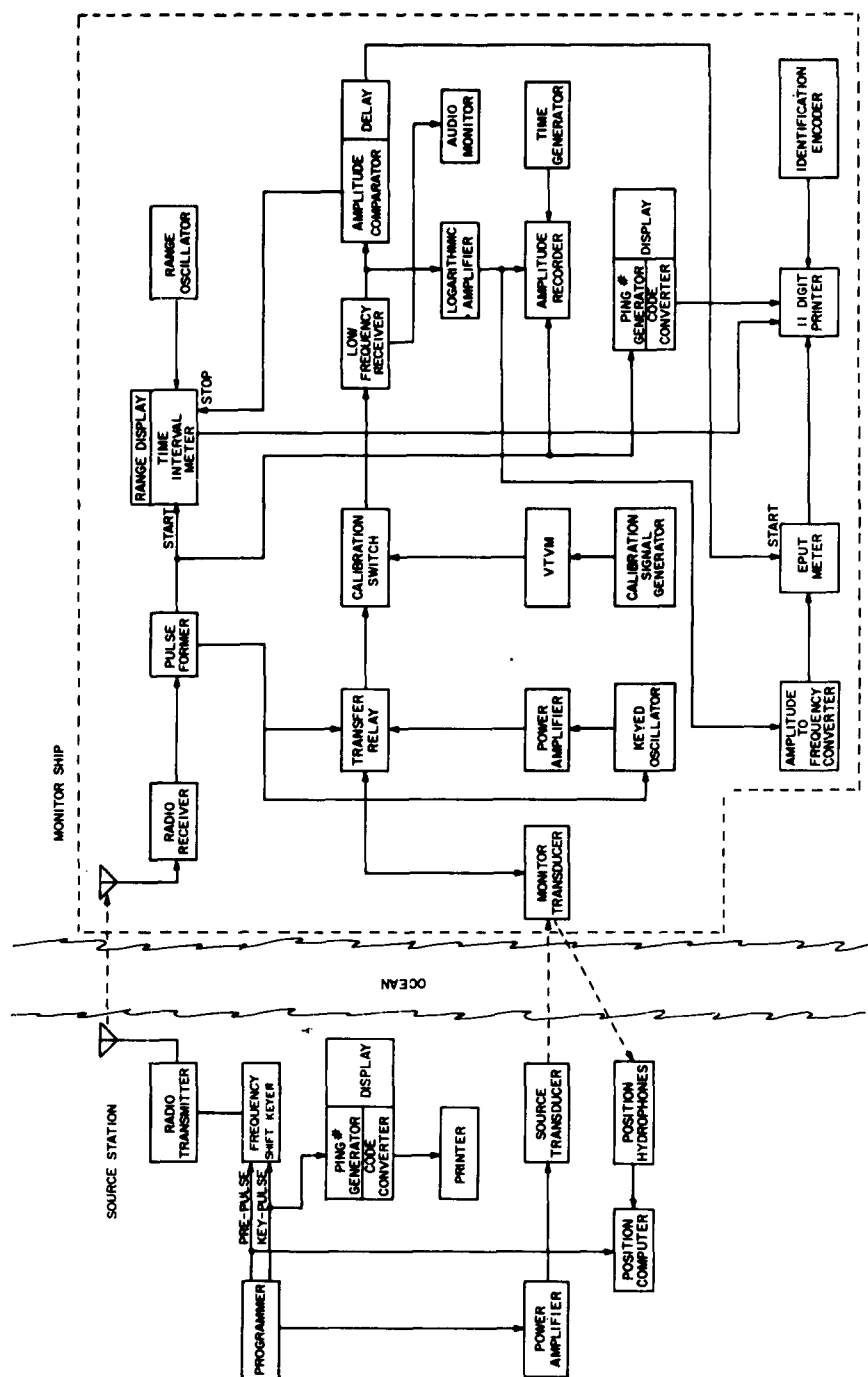


Fig. 52 - Block diagram - acoustic monitoring instrumentation

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The three electric cables enter the array through cable horns (figure 53). These provide a minimum bending radius at the point of entrance. Behind each of the horns is an armor termination. The double armor is removed from the cable beyond this point. The armor clamp also contains a guillotine cutter. This will cut the cable at this point if the cable loads become large enough to be harmful to the cable machinery.

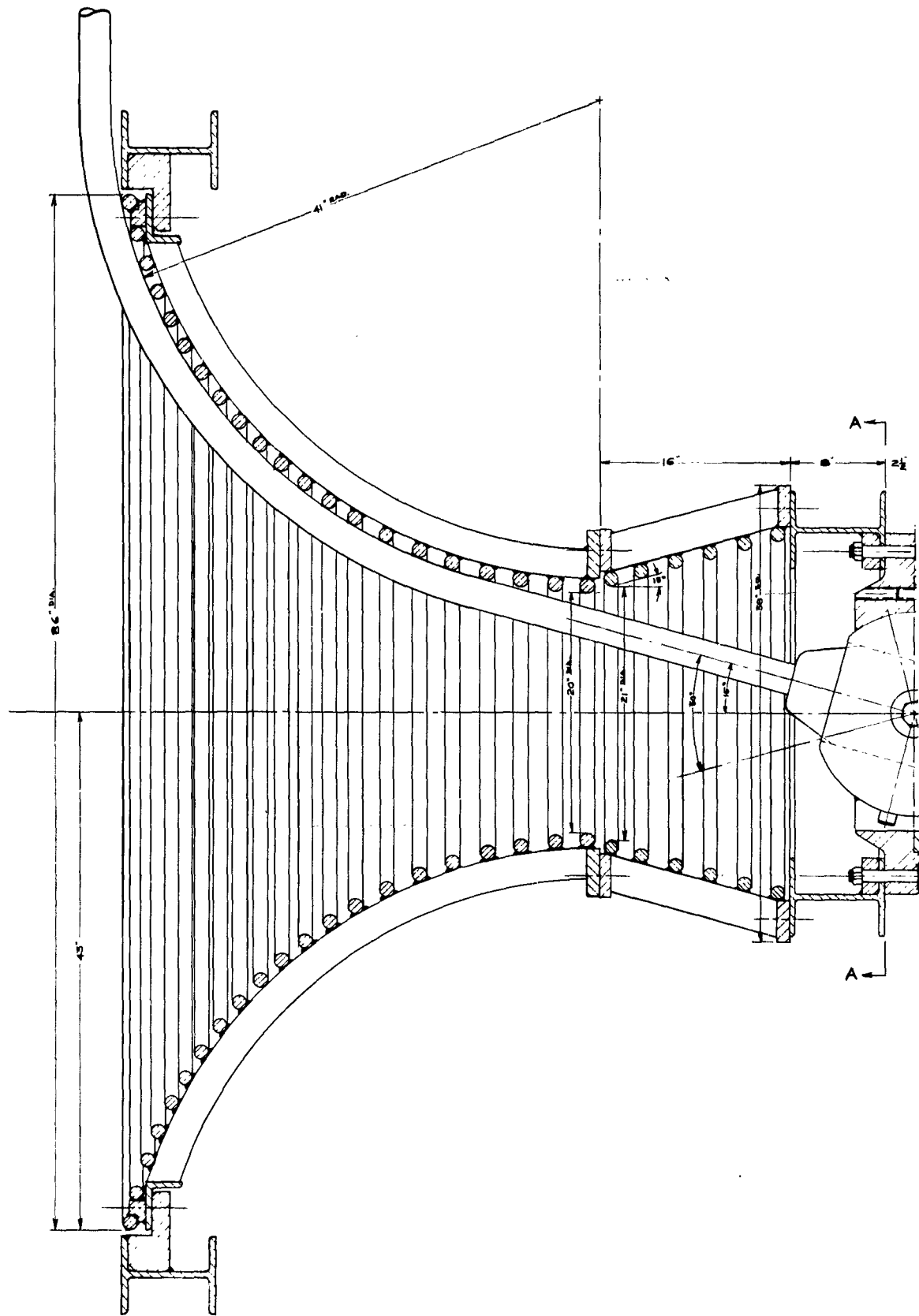
The three cables then pass through the structure to the junction box (figure 54). Inside the junction box the various conductors are broken out of the cables and the conductors are affixed to terminations which are part of a distribution system. The lines go from the junction box to four component tanks. Within the component tanks are current transformers, blocking and tuning capacitors and rectifiers for supplying the dc polarization power from the three phase current transmitted. The lines leave the component tanks, return to the junction box and from there go to the individual modules. Each component tank supplies the driving power for five modules, each module operating from a separate secondary on the transformer. The four groups of five modules are paralleled.

The component tanks and junction box have bladders mounted on them to provide pressure equalization. This reduces the structural requirements.

There is a fourth cable used for instrumentation which will be used during the fixed installation. This cable will supply power to and carry signals from an instrumentation capsule mounted on the structure (figure 55).

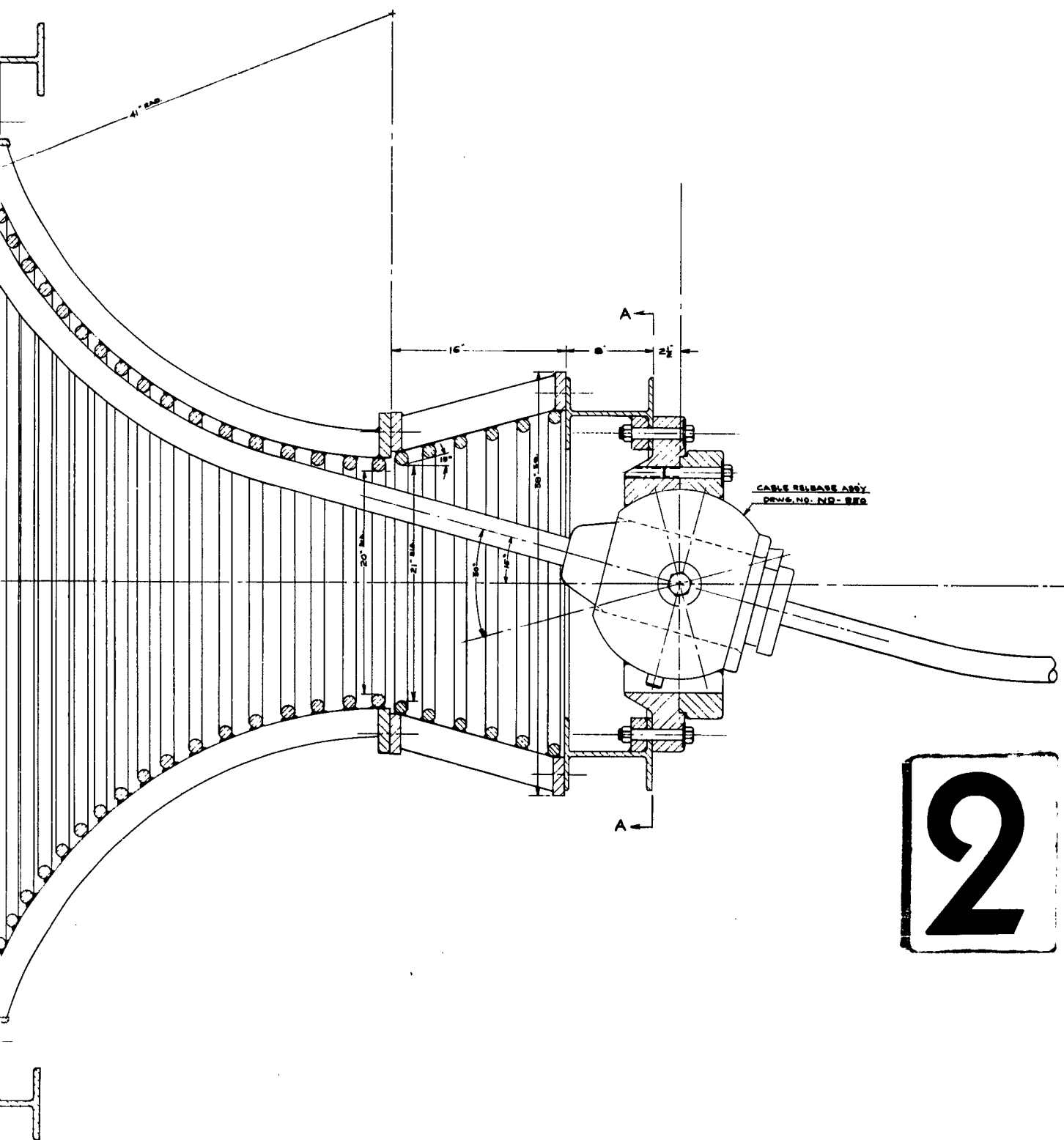
Nitrogen gas is supplied to each of the pressure release tubes within the module. This gas is supplied by ten pressurized bottles mounted within the structure (figure 56). The pressure within the bottles is about 2000 psi. By means of valves and regulators, this is supplied to the modules in a range adjustable between zero and fifty pounds of ambient pressure. A pressure sensor within a regulator controls the volume of gas delivered such that, when the pressure differential between the gas in the tubes and that of the water is at some predetermined minimum amount, no further pressurization of the tubes is permitted. This reduces the amount of structural strength required of the pressure release tubes and reduces the possibility of leakage.

1



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Fig. 53 - Cable entry horn and cutter assembly



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Fig. 53 - Cable entry horn and cutter assembly

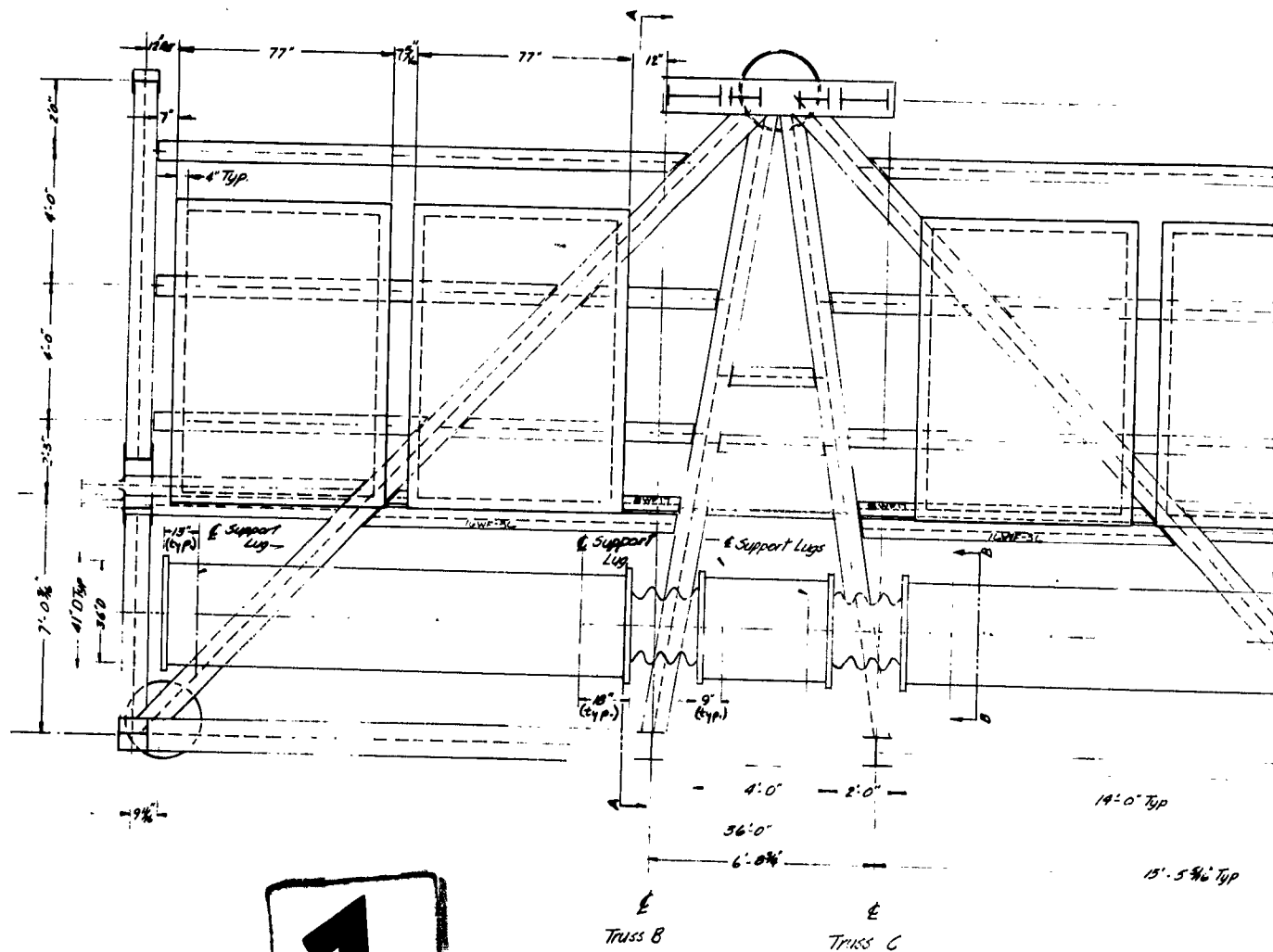


Fig. 54 - Junction box and component tank layout

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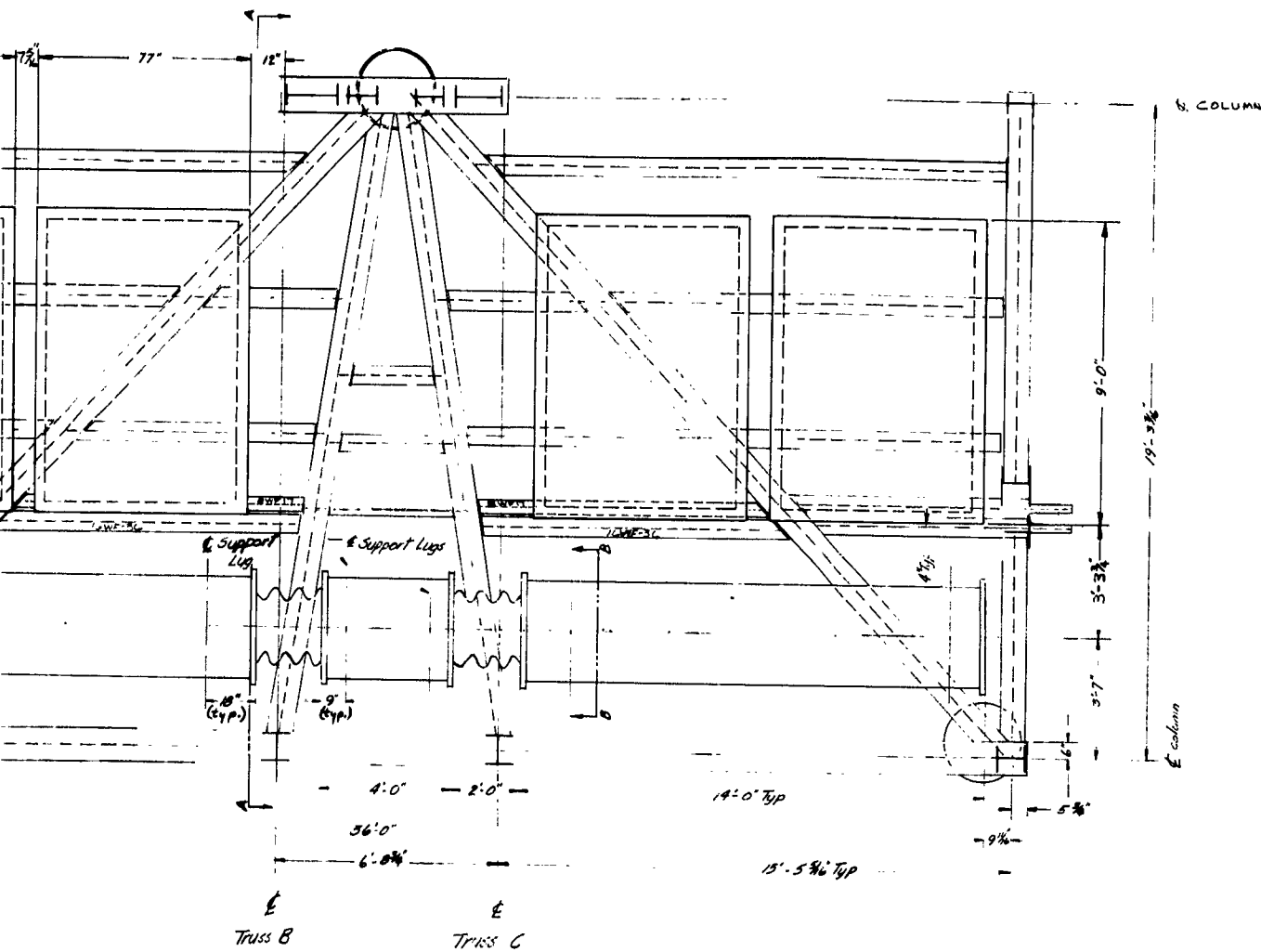
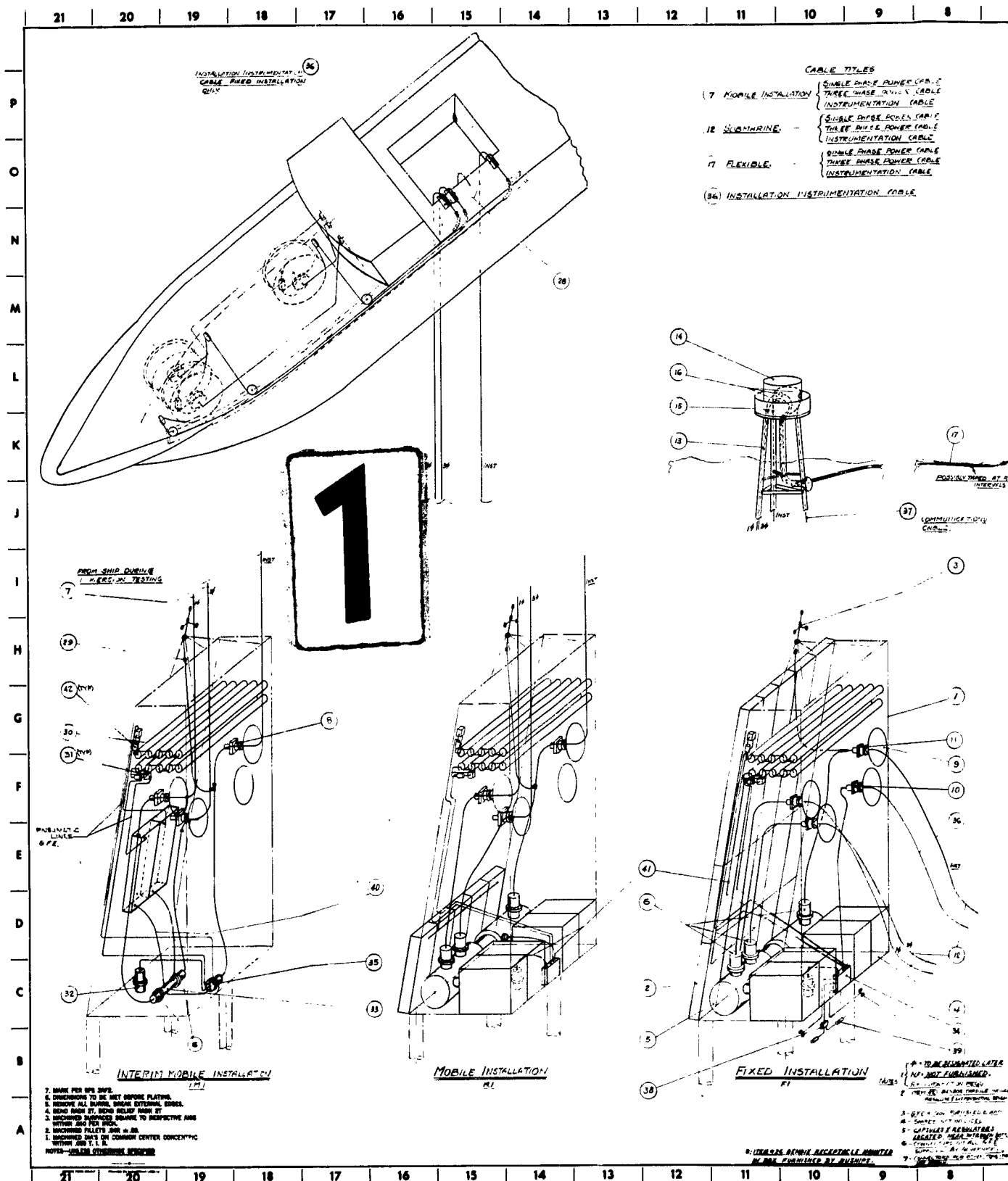


Fig. 54 - Junction box and component tank layout

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Fig. 55 - Array systems schematic depicting the phases of operation

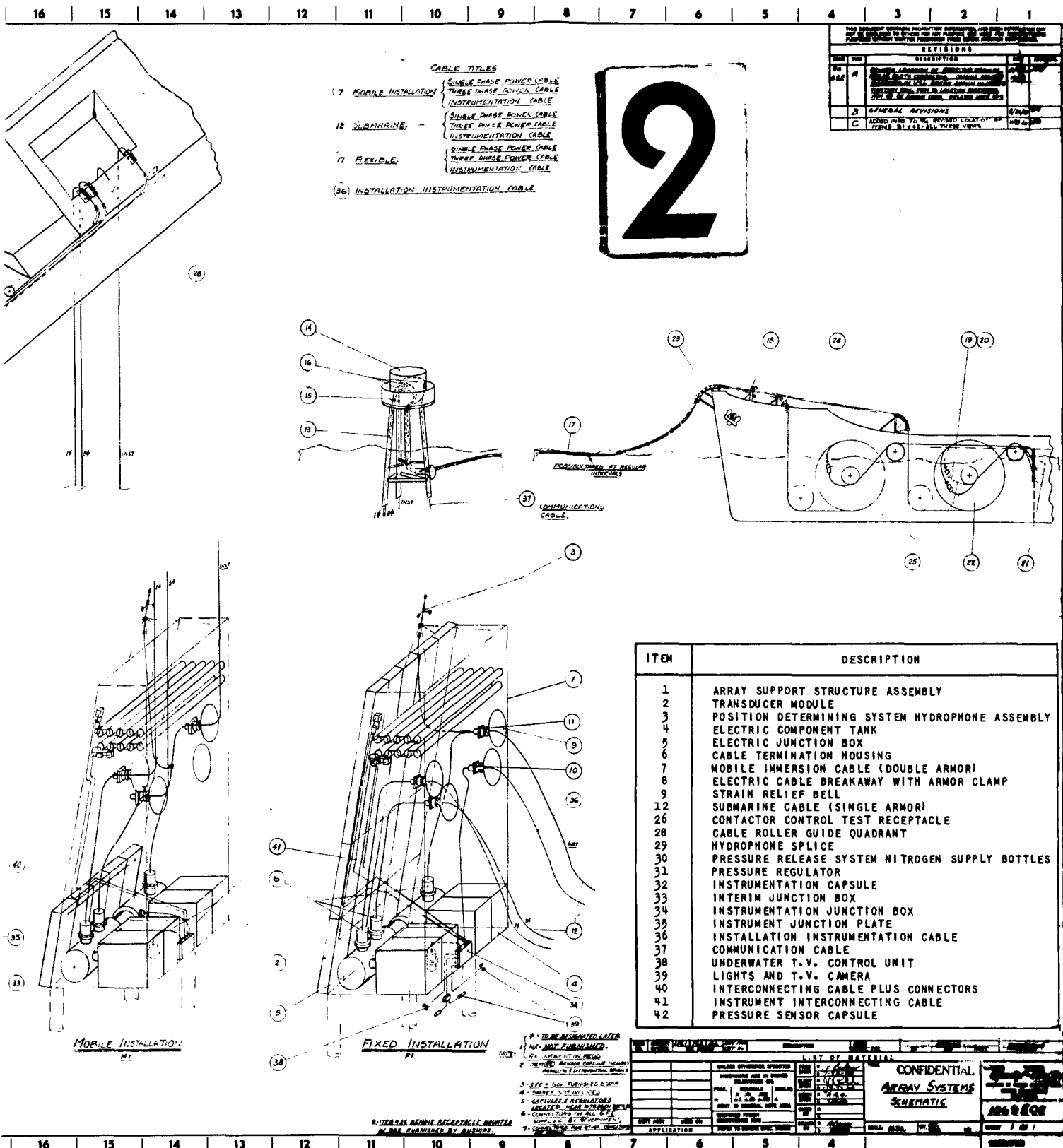


Fig. 55 - Array systems schematic depicting the phases of operation

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Fig. 56 - Array support structure showing five nitrogen bottles and cable terminations looking into right side of vertical truss D

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The ten bottles can be operated singly or in parallel groups of five due to the valve arrangement. Each group of five bottles will supply nitrogen to ten transducers.

The module is a matrix of seventy-two transducers in six columns and twelve rows (figures 57, 58, 59). The housing is an egg-crate type construction; the compartments are constructed of 3/8 inch plate surrounded by eighteen by forty-two channels (figure 60). The front and back face of each compartment is open. The overall dimensions of each module are 12-1/2 feet high, 6-1/2 feet wide and twenty-three inches deep. Behind each row there is a pressure release tube. This tube is a stainless steel pipe squashed to a flat shape of six inches by one-half inch by six feet long. The wall thickness is one-eighth inch, leaving an air gap of one-quarter inch. There are twelve tubes which are connected in series for pressurization (figures 61, 62).

A ball check valve is mounted on each module to prevent water leakage into the entire pressure system should the tubes of a single module become damaged. There is also a blow-off valve to discharge the gas from the tubes as the water pressure decreases when the array is raised. The transducers are placed in the individual compartments where they are retained by bolting a piece of angle iron to the structure and against the front and back face of the transducer. Each angle has soft rubber attached to it so that the vibration of the unit is not affected by this constraint.

Two Teflon strips are glued to the surface under each transducer and a single strip is glued to each of the remaining surfaces of the compartments to reduce the friction (figure 60).

The electric lines from each transducer connect to a cable harness. The units are electrically connected in twelve parallel groups of six transducers in series (figure 62).

A shear lug is welded to the back of each vertical channel. The bolt holes for mounting the module to the structure are located from the bottom surface of this shear lug which locates the module on the structure.

Twenty of the above modules are mounted on a structure to produce a planar array approximately thirty-two feet wide by fifty feet long. The modules are mounted in a matrix of four rows of five columns.

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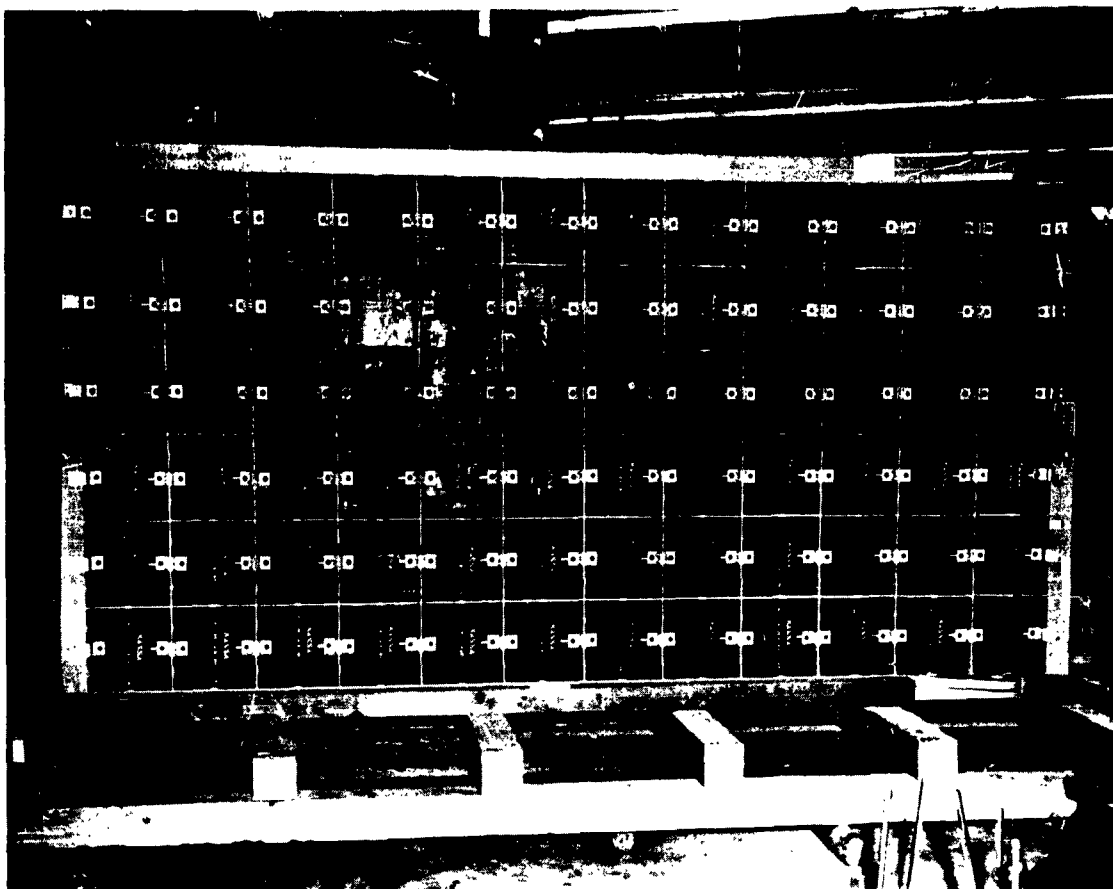


Fig. 57 - Front face of transducer module being prepared for shipment. Module is on its side.

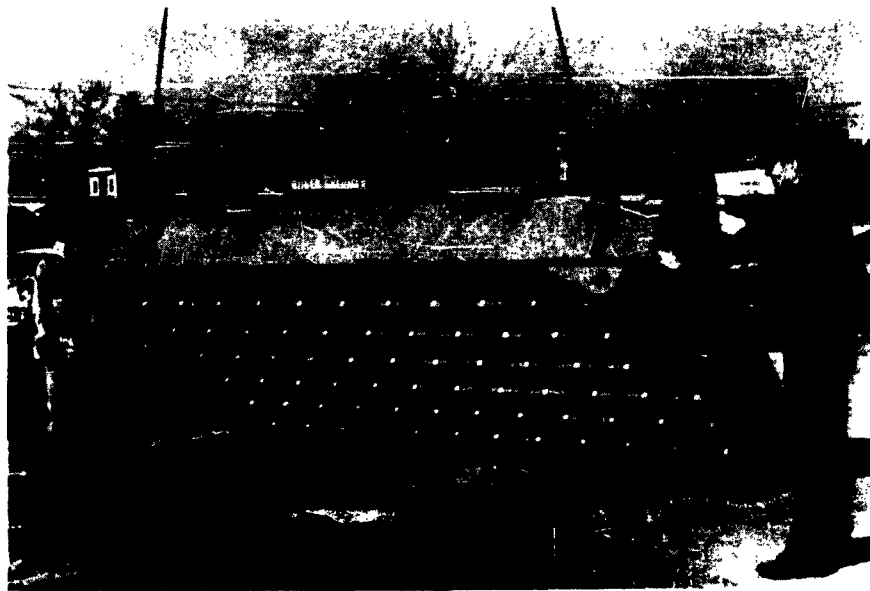


Fig. 58 - Side view of module showing front, side and top lifting eyes, points of attachment to support structure

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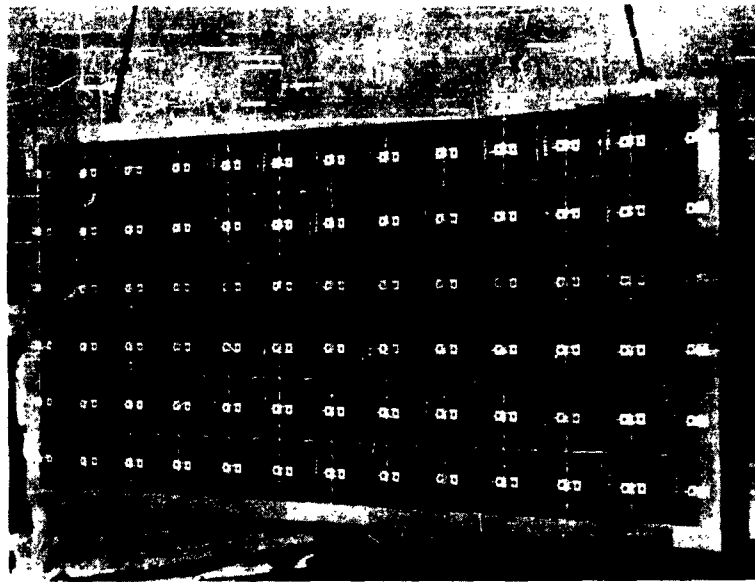


Fig. 59 - Front view of module. Note angles bolted to housing to retain transducer

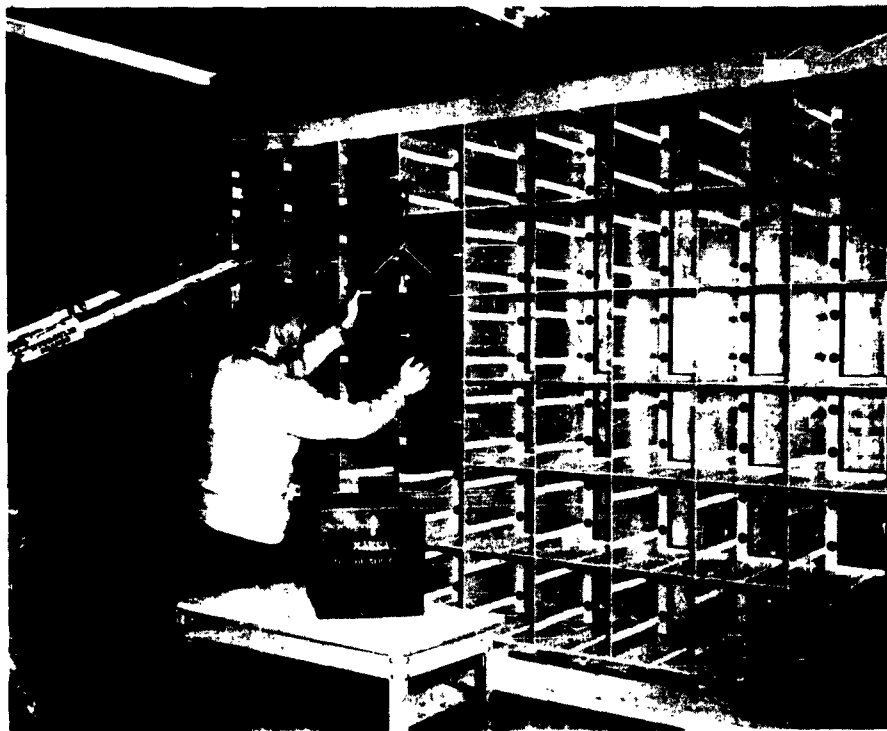


Fig. 60 - Front view of housing showing individual compartments with nylon strips

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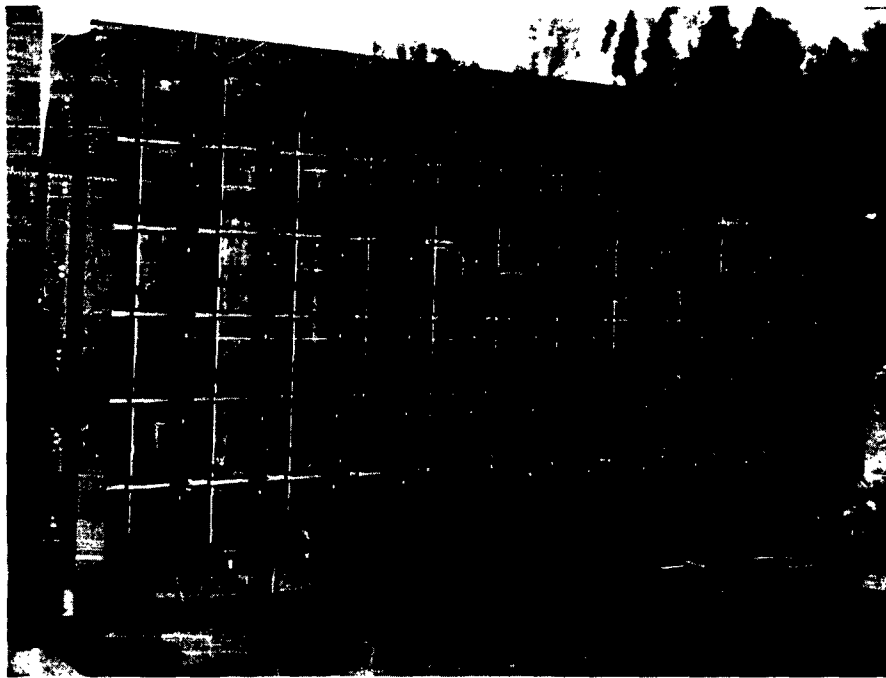


Fig. 61 - Back view of module showing pressure release tubes and shear lugs

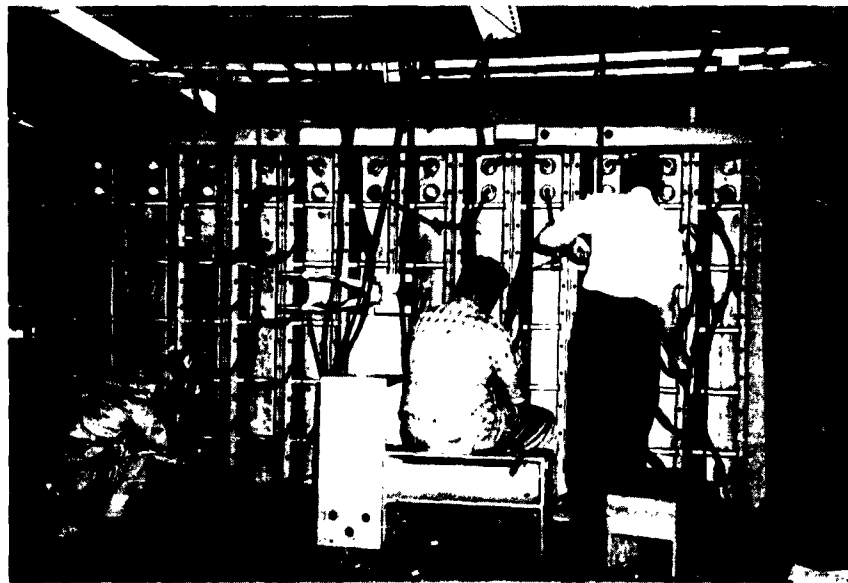


Fig. 62 - Back view of module showing pressure tubes being interconnected and transducer leads being attached to the harnesses

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The face of the array is inclined eleven degrees to the vertical (figure 63). The structure is 37-1/2 feet wide by fifty-six feet high by twenty feet deep at the base (figure 64). The structural members are sized to avoid the possibility of parts of the structure having a vibration frequency close to the range of the transducer.

The structure will be housed in the well of the USNS MISSION CAPIS-TRANO where it will be raised and lowered by means of the main array winches. The wire rope passes through guide barrels on the structure and around a sheave located at the base of the structure (figure 63). This sheave is located to permit raising the structure so that the top of the base beam is at deck level, thus permitting maintenance. During transportation, the structure will be secured to the ship by means of the lock-out points located on the back and sides.

The total weight of the array structure is about 690,000 pounds in air and 400,000 pounds in water.

TABLE OF WEIGHTS

<u>Unit</u>	<u>Dry (lbs.)</u>	<u>Wet (lbs.)</u>
Modules	310,000	225,000
Array support structure	162,000	141,000
Component tanks	130,000	3,000
Junction box	23,000	9,000
Cable horns	8,000	7,000
Nitrogen bottles	16,000	-
Instrument capsule	2,500	2,000
Miscellaneous fittings	8,000	7,000
TOTAL	659,500	394,000

Operation will commence with two modules on the array structure (figure 64). After several months of operating as a mobile source, this will be increased to ten modules. Finally, all twenty will be placed on the structure. Operation will continue as a mobile source for an indefinite period. After satisfactory operation has been proved, the structure will be placed on the ocean floor in 1200 feet of water and become a fixed source. During the above changes in the number of modules, the component tanks and junction boxes will be added as needed. Two will be used when there are ten modules and all four will be mounted in the structure when there are twenty modules (figure 55).

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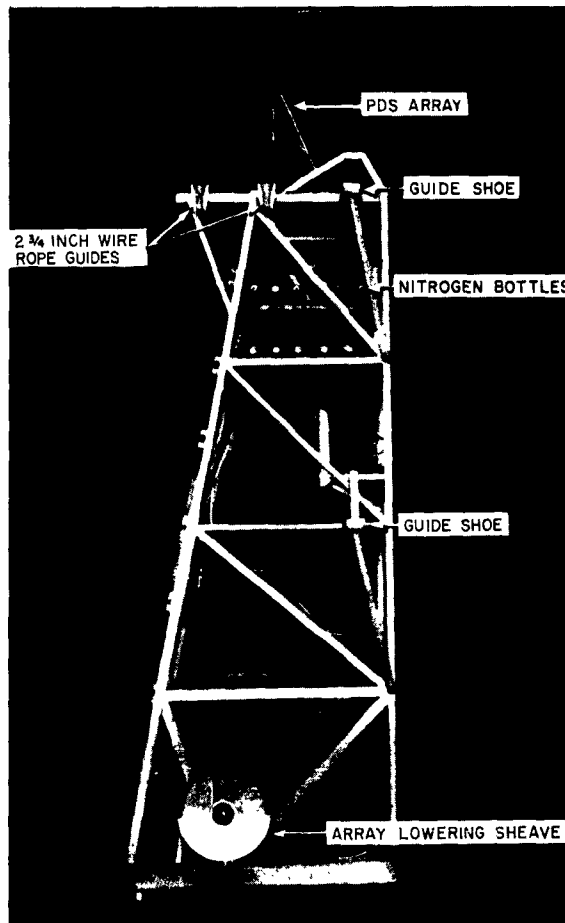


Fig. 63 - Array structure looking into vertical truss D

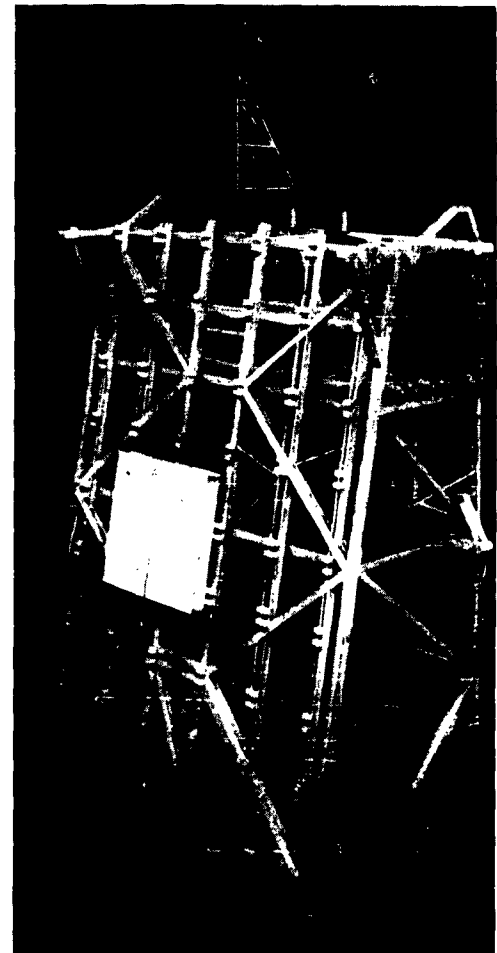


Fig. 64 - Array structure with two modules mounted. This arrangement will be used in the initial test phase.

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Array Handling System

The previously described transducer array will be operated from the USNS MISSION CAPISTRANO. In order to do this, a handling system has been installed on this ship which enables one to transport the array, raise and lower it, retrieve it while the ship is operating in a seaway, guide it to a fixed foundation for a fixed installation, orient it for a fixed installation and finally to tend the electric cables during these operations.

The individual components can best be indicated by reference to the deck plan of the USNS MISSION CAPISTRANO. The following is a list of the units that comprise the system, their use and location on the ship.

1. Array lowering winches - raise and lower the array (frames 68 and 46-1/2)(figures 65, 66).
 - a. Main array sheave and bitter end connection (frames 55 and 59).
 - b. Main array cable tunnel (frame 61 through 64).
 - c. Roller path guides (frames 55, 59).
 - d. Footage counter system.
2. Guide and buffer system and fixed supports - guides the array into the well during retrieving (frames 55 and 59).
3. Hinged supports and lockout system - secures the array in the well during transportation (frames 55 and 59).
4. BB 61 class windlass - provides a means for lowering the foundation for the fixed installation and a guide line for lowering the array to this foundation (frames 49-1/2 and 52-1/2 port).
5. Tagline winch - orients the array in azimuth in order to place it on the foundation in the fixed installation (frames 58 and 59 port).
6. Electric cable handling machinery - tends the cable during operation. Centerline cargo tanks two and three (frames 65 through 71).

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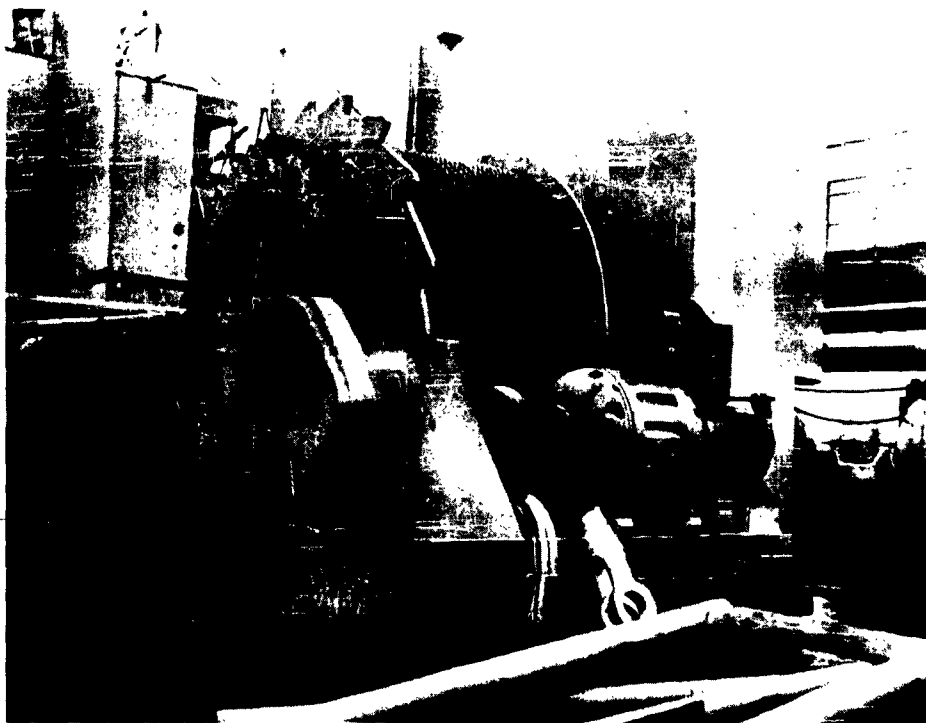


Fig. 65 - Aft array winch with 2-3/4-inch wire rope



Fig. 66 - Aft main array handling winch prior to winding the 2-3/4-inch wire rope

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- a. footage counter
- b. cable trunk
- c. roller path guides in well

7. Array control station - this is a platform on which the controls for the array winches and electric cable winches will be located. It is a control station for raising and lowering the array. (frame 60 aft end of midship deckhouse)

Two array lowering winches are provided with characteristics as follows:

Manufacturer	R. G. LaTourneau
Line pull	300,000 pounds on topmost layer
Spooling capacity	3000 feet of 2-3/4 inch wire rope
Construction	Weldment
Drum barrel diameter	72 inches
Motor	200 hp wound rotor 440 volt, 3 phase, 60 cycle

The motor controls provide stepped speed variation of five speeds for lowering and one for raising. The maximum speed is approximately 17.5 feet per minute on the rope or 8.75 feet per minute on the array while raising. Lowering speeds are not known yet, but the maximum is expected to be about the same as above.

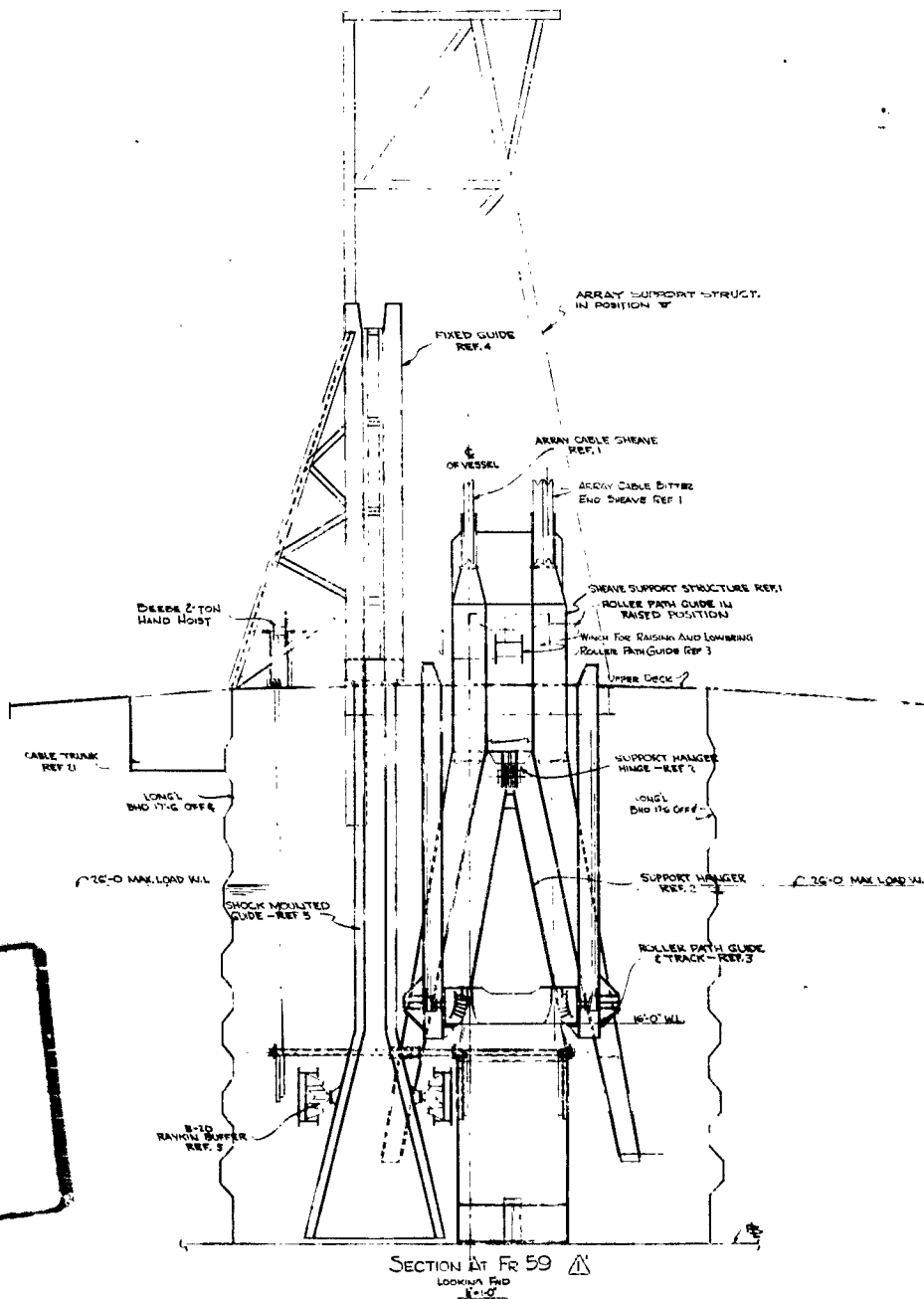
The wire rope was produced by Bethlehem Steel and has a breaking strength of approximately 800,000 pounds. A length of 3000 feet is spooled onto each winch. Since operation of the two winches is identical, the operation of only one (that is, the forward winch) is described. The general arrangement of these and of other associated parts of the array handling system is shown in figure 67.

The wire rope leaves the winch and passes aft through the main array cable tunnel to the main array sheave at frame 59. The rope passes over the sheave and into the well. It then goes through a guide barrel on the array around a sheave at the base of the array and back through a second guide barrel. The cable then makes one and one-half turns around the double sheave on the bitter end structure and is socketed off on this structure. This provides two two-part lines for the array. The distance between the array winch and the main array sheave is sufficient that the fleeting angle is about one and one-half degrees, which permits the wire rope to spool on the drums without the aid of a level wind.

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CABLE WHICH
WE UNFOURD
ARRAY IS BEING
CHECKED

ARRAY CABLE
END SHEAVE
REF. 1

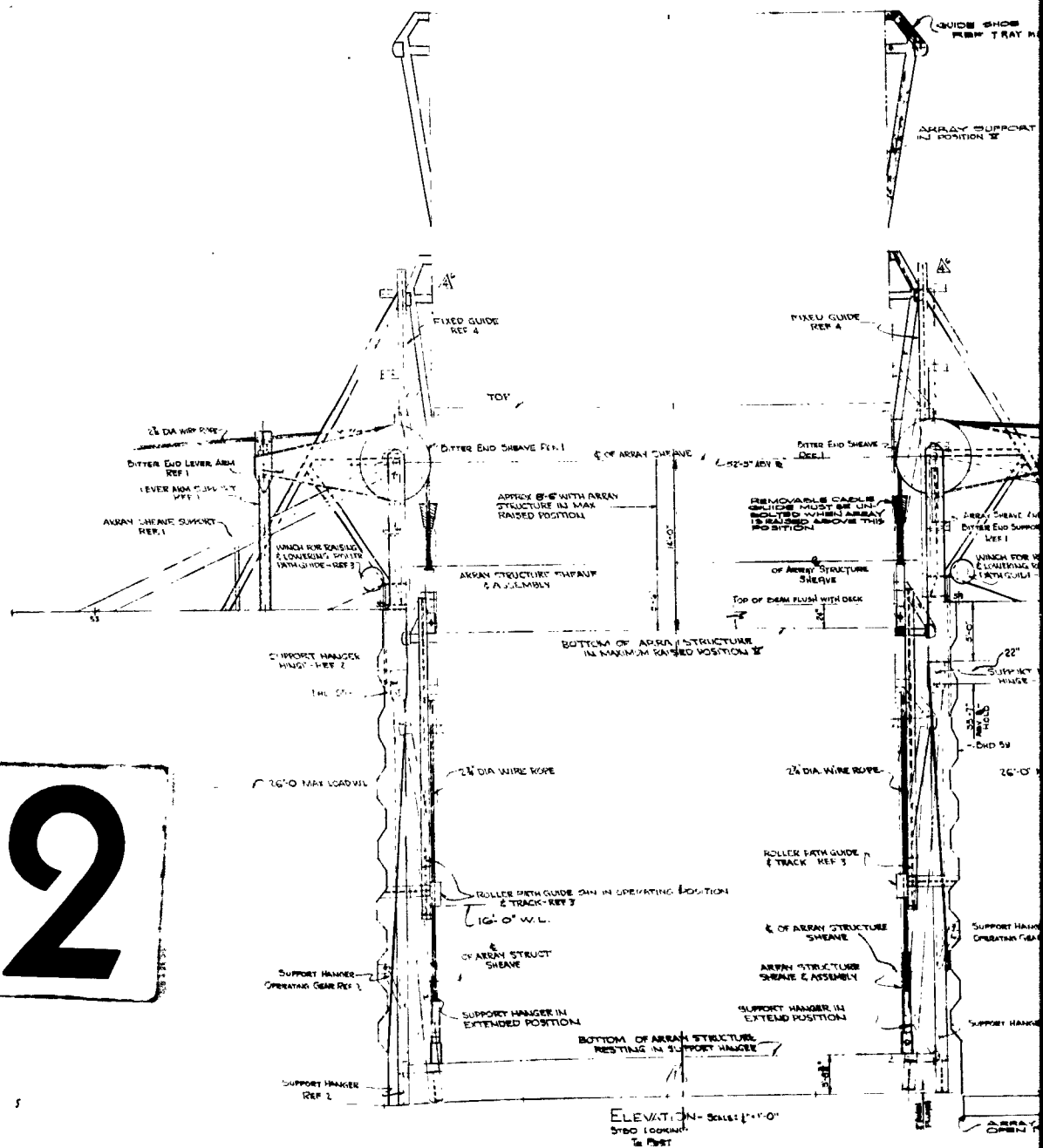
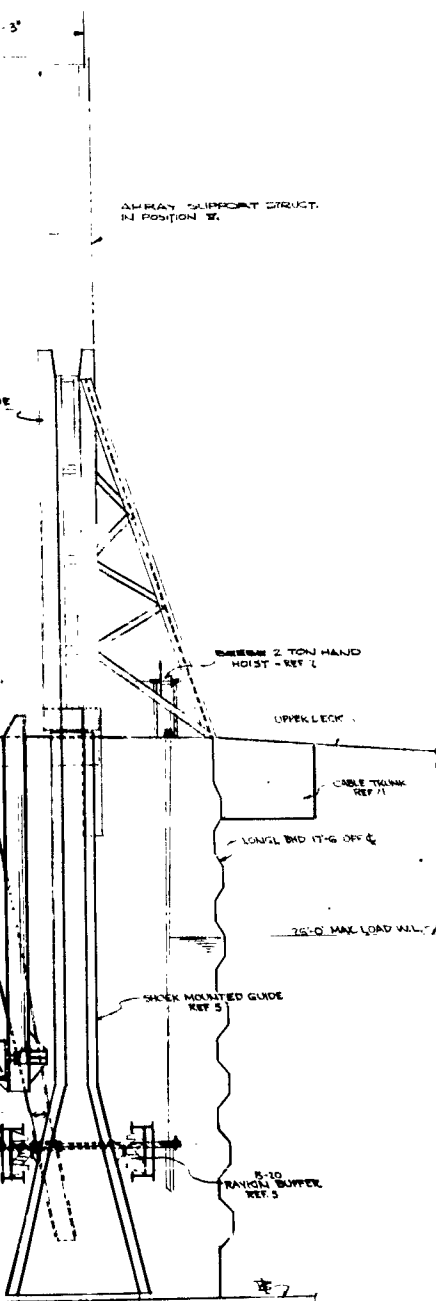
SHEAVE SUPPORT OF
REF. 1
ROLLER WITH GUIDE
RAISED POSITION
WHEEL FOR RAISING AND
LOWERING ROLLER PATH
REF. 2

SUPPORT HANGER
HINGE REF. 2
LONGER END 176
OFF

16'-0" MAX LOAD WLL
SUPPORT HANGER
REF. 2

ROLLER WITH GUIDE
(TRACK - REF. 3)

16'-0" W. L.



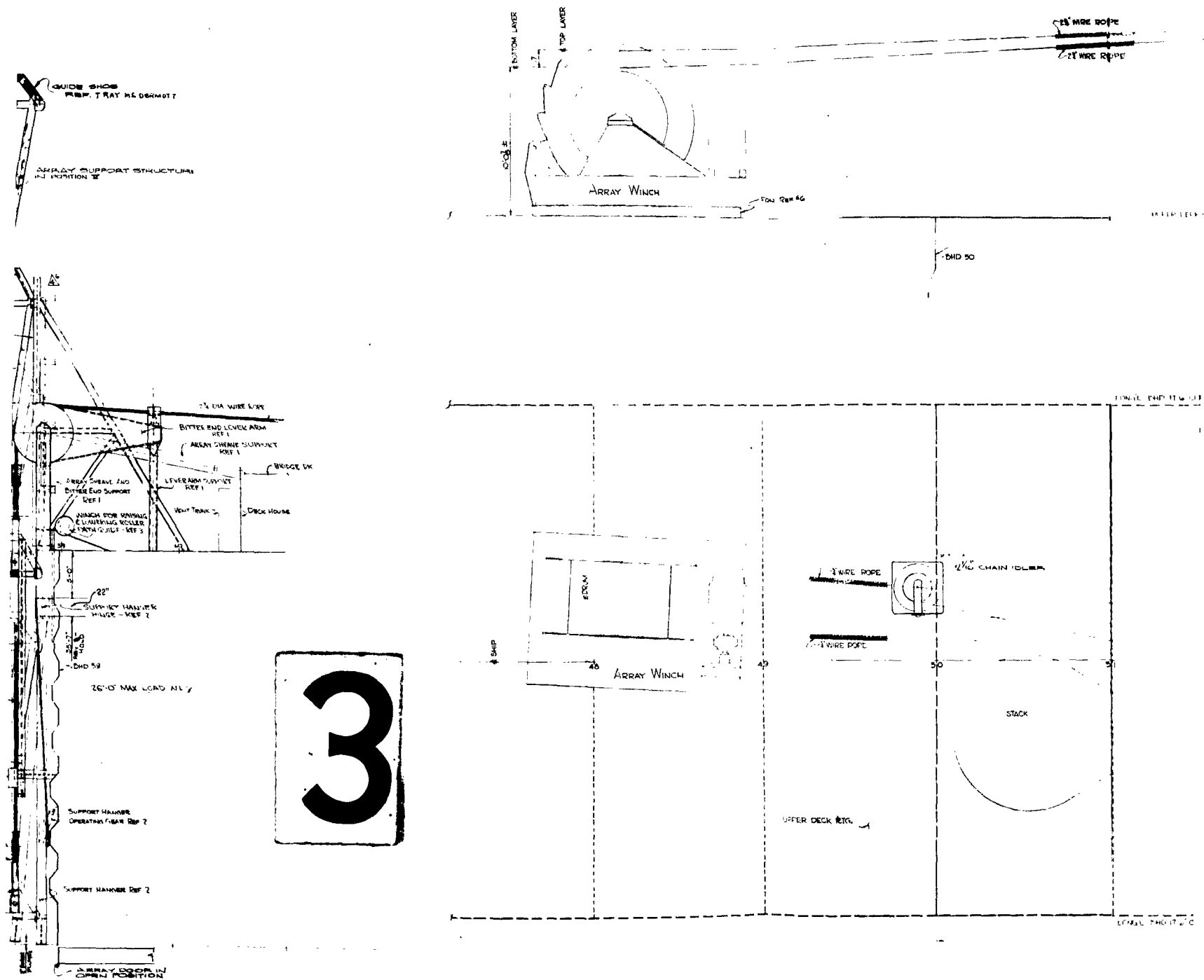
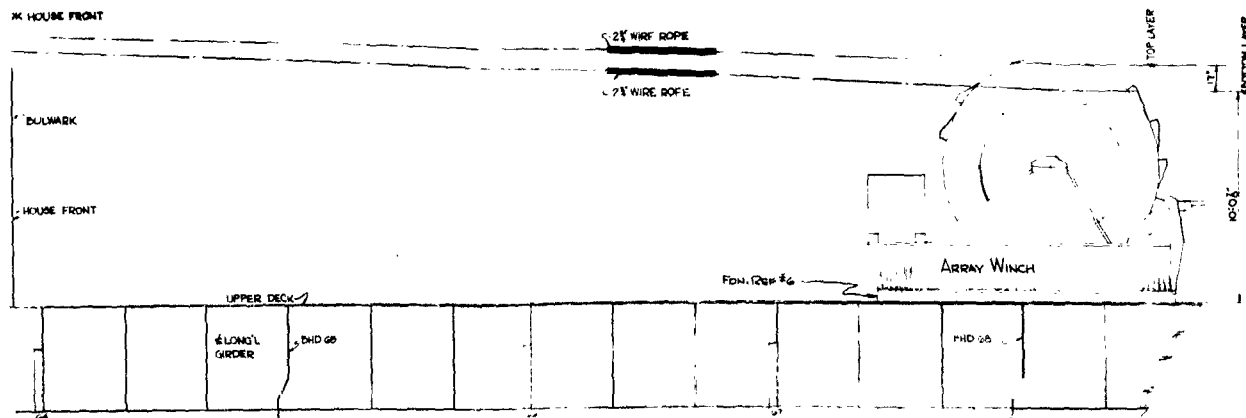


Fig. 67 - Arrangement and

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Is of array winches and buffer guide system

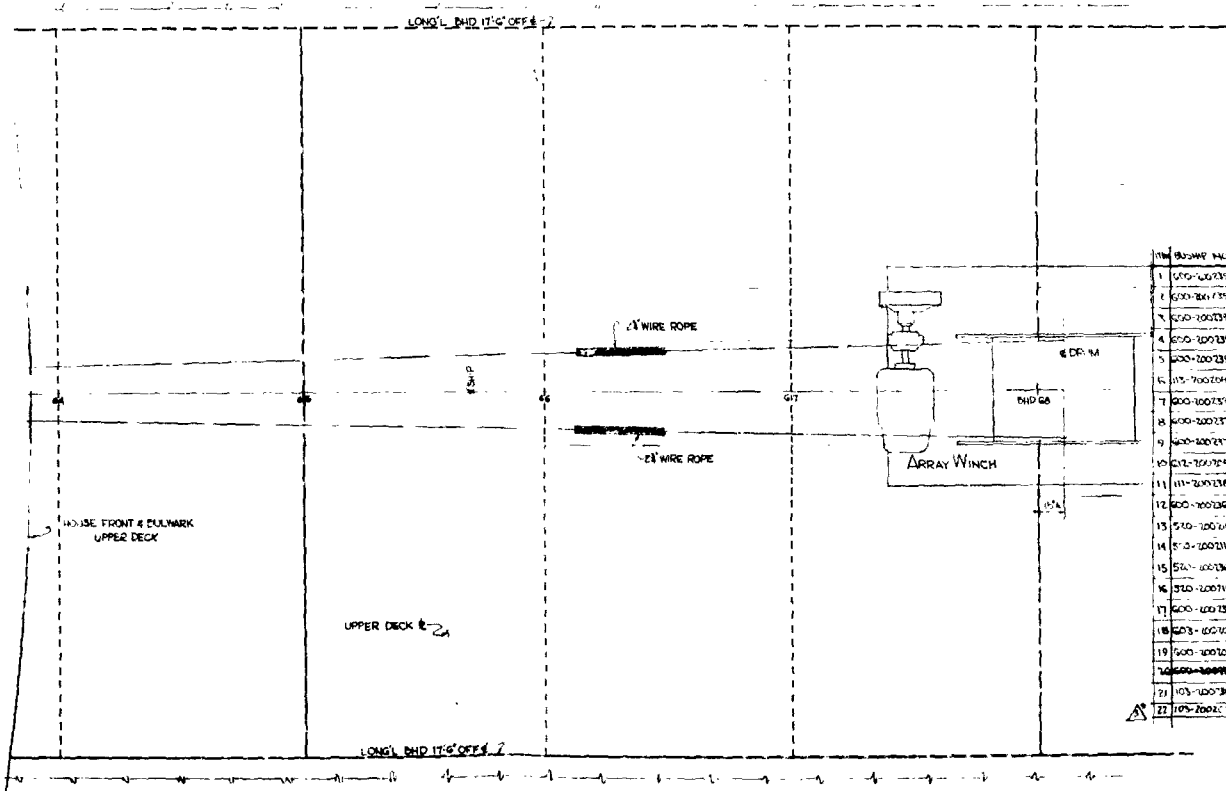


GENERAL NOTES

1. ALL DIMENSIONS SHOWN MUST BE MAINTAINED AS ACCURATELY AS POSSIBLE.
2. ALL DIMENSIONS SHOWN CHECK SHIP ARE TO BE HELD AS CLOSELY AS POSSIBLE. BUT MAY BE ADJUSTED TO SUIT ACTUAL DIMENSIONS OF THE SHIP.
3. DIMENSIONS NOT SHOWN WOULD BE CHECK SHIP ARE NOT CRITICAL. IDEAL FOR AS THE RELATIONSHIP BETWEEN THE SHIP'S STRUCTURE & THE ARRAY STRUCTURE IS CONCERNED.

SPECIAL NOTE

VERIFY ALL DIMENSIONS IN FIELD PRIOR TO ANY FABRICATION WORK.
AMW NOT RESPONSIBLE FOR EXISTING OMISSIONS OR INTERFERENCES TO EQUIPMENT AND/OR STRUCTURES NOT INSTALLED BY AMW



REFERENCES

ITEM	SYMBOL NO.	AMW NO.	TITLE
1	100-100100	100-100	ARRAY & LIFTS OF ARRAY SHEAVE & BITTER END STRUCT
2	100-100101	100-101	ARRAY & LIFTS OF SUPPORT WALKER FOR ARRAY STRUCTURE
3	100-100102	100-102	ARRAY & LIFTS OF ROLLER WITH CLIPS
4	100-100103	100-103	FIXED GUIDES FOR ARRAY STRUCTURE ABOVE MAIN DECK
5	100-100104	100-104	ARRAY & LIFTS OF SHOCK MOUNTED GUIDES
6	100-100105	100-105	MISC. FOUNDATIONS
7	100-100106	100-106	ARRAY & LIFTS OF UPPER & LOWER STABILIZING TRENDS
8	100-100107	100-107	CASTING FOR MAIN ARRAY SHEAVE & FOOTING COUNTER
9	100-100108	100-108	BITTER END CASTING
10	100-100109	100-109	ARRAY OF QTES BRIDGE OR MODIFICATION
11	100-100110	100-110	STRUCTURAL MARINE & SHEET METAL SHIPS
12	100-100111	100-111	ARRAY WHEEL DOOR - ARRAY & LIFTS
13	100-100112	100-112	ROLLER FAIRLEAD FOR 1 1/2" CHAIN
14	100-100113	100-113	ARRAY & LIFTS OF 80-51 WINDLASS & EQUIP ETC.
15	100-100114	100-114	OUTRIGGERS & ARRAY WHEEL FAIRLEADS ETC.
16	100-100115	100-115	FAIRLEAD FOR 1 1/2" CHAIN
17	100-100116	100-116	TAGLINE WINCH ARRAY & LIFTS
18	100-100117	100-117	INCLINED LINES & VERTICAL LINES
19	100-100118	100-118	MOORING ARRAY FOR LST STEER WINCHES
20	100-100119	100-119	ARRAY WHEEL DOOR
21	100-100120	100-120	ARRAY WHEEL DOOR
22	100-100121	100-121	ARRAY WHEEL DOOR

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In order to prevent the wire rope from riding the flanges of the main array sheave when the ship is rolling, a roller path guide is installed in the well. This assures that the cable is at all times perpendicular to the axis of the sheave.

The bitter end structure consists of a double sheave which is attached to a lever arm. This structure would be free to rotate about the center of the double sheave; however, the end of the lever arm is attached to the ship's structure by means of a load cell. As the structure attempts to rotate, it loads up the cell in the proportion to the weight on the wire rope. This will make it possible to monitor the static and dynamic loads on the system.

A footage counter system is also operated from the cable. Transmitters are located at the forward and aft ends of the well to monitor the amount of wire rope payed out and transmit the information to the control station.

As the array is retrieved, it is probable that due to wave action there will be relative motion between the array and the ship. In order to preclude the possibility of damage due to impact, a guide and buffer has been installed on the ship (figures 67 and 68). The guides are channels flared at their lower extremity. One is mounted at the forward end of the well and the other at the aft end. The upper extremity is loosely joined to the ship's structure by means of a pin connection. This permits freedom of motion in every direction but vertical. At the flared end of each guide, two buffers are placed between the guide and the ship. This system has been designed to permit recovery of the array when the ship is rolling five degrees and pitching two degrees. A roll of thirty degrees and a pitch of five degrees can be accommodated by the physical arrangement of the guide if this is absolutely necessary. The energy absorption characteristics of the system are insufficient for this condition, however. The length and width of the flare are significant in this respect since, as the array is brought further into the ship, it approaches the center of roll and the amount of relative motion decreases. Since only two shoes on the array structure (figure 64) are in contact with the guide at one time, if the progress of the array were followed through the well, it would be seen that a minimum of impact is incurred. As the array advances through the well, its moment of inertia decreases since the center of gravity of the array approaches the center of roll. As this occurs, the shoes engage the fixed guides on the deck and the array is caused to move with the ship.

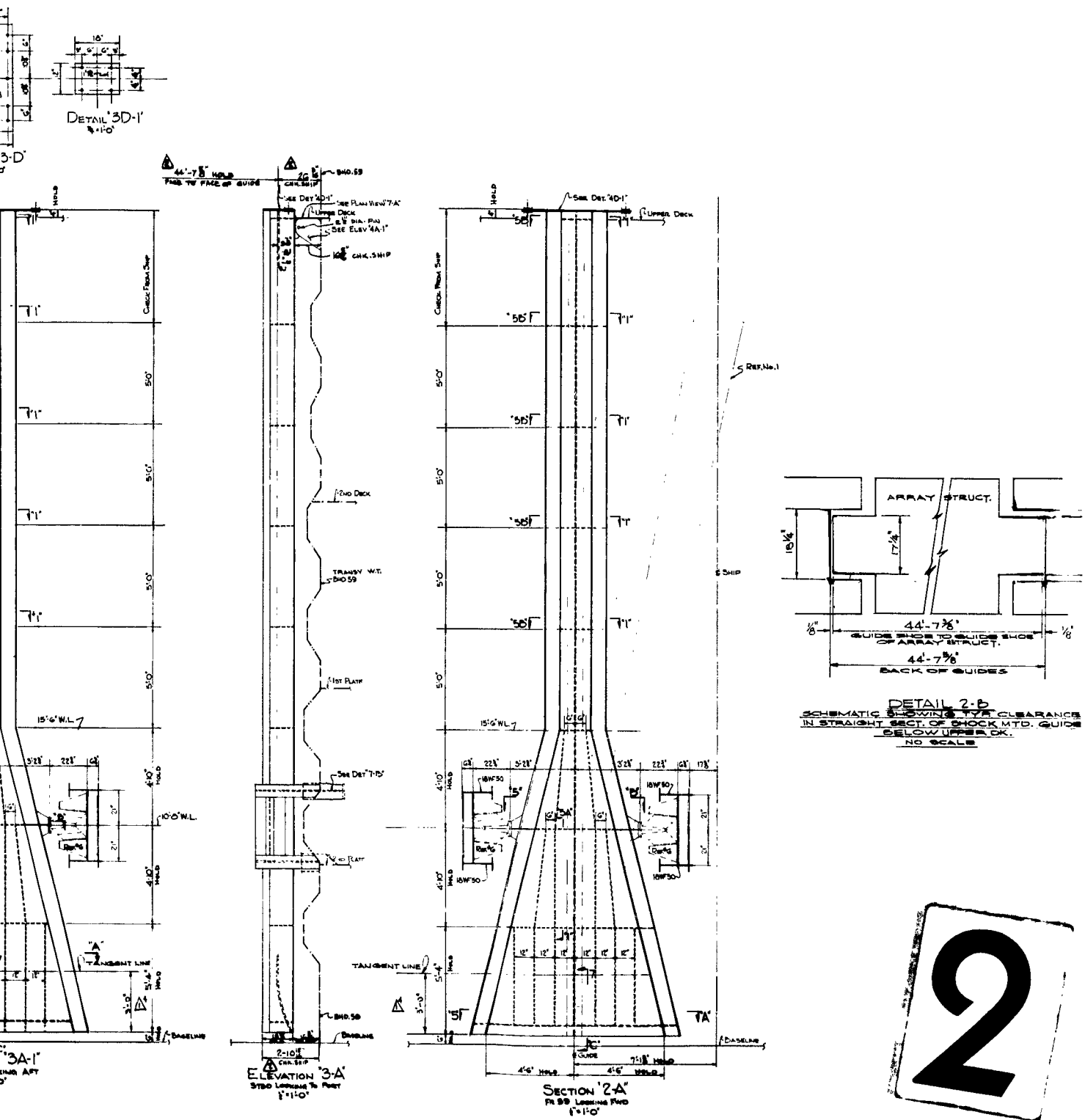


Fig. 68 - Shock mounted guide details

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Once the array is completely within the ship, the hinged supports and lockout system are utilized to support it and secure it. This permits the unloading of the wire rope and the winches. The construction of this is shown in figures 67, 69, 70.

The hinged supports are mounted in the well at the fore and aft ends. They are rotated away from the side of the ship by means of a wire rope attached to a quadrant mounted on the support. On each support a curved bearing plate is mounted which mates with a complementary bearing plate on the array structure.

After this has been done, the lockout system can be engaged. This consists of I beams which are pinned to the ship's structure on one end and the array structure on the other. The lockouts secure the array in the well, thus preventing any damage due to relative motion of the ship and array during transportation.

The windlass is of the electro-hydraulic type having two independent power units, two capstan heads and two wildcats which can be driven in either direction at any speed up to maximum by varying the stroke of the hydraulic pump. (figure 71)

Each wildcat and capstan is driven through shafting from a common gear train. During operation of the wildcat, rotation of the capstan will result. The wildcat can be disconnected from the gear train by means of a locking pin, thereby permitting independent operation of the capstan. Each wildcat is capable of hoisting one anchor (31,500 pounds) and its 3-3/8 inch heavy duty die lock steel chain (41,800 pounds) from a depth of sixty fathoms at an average rate of six fathoms per minute and from a depth of 100 fathoms up to sixty fathoms at no specified speed.

The capstans are capable of developing a pull of 15,000 pounds on a ten-inch circumference manila hawser at a rope speed of 125 feet per minute.

The power units consist of a continuously operating 225 hp General Electric Company motor, equipped with a thruster-type electric brake of 325 foot-pounds rated capacity, connected by flexible coupling to a gear reduction unit, and a size fifty K Waterbury hydraulic pump (A-end). A size fifty K Waterbury motor (B-end) is mounted vertically on each main gear reduction unit to drive the wildcats and capstan heads.

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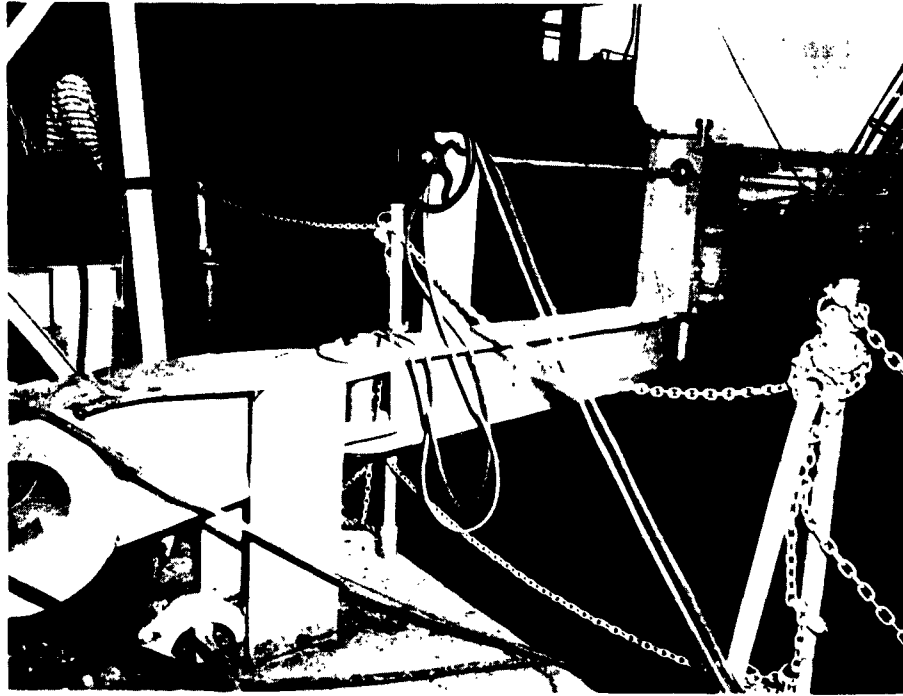


Fig. 69 - Lockout device

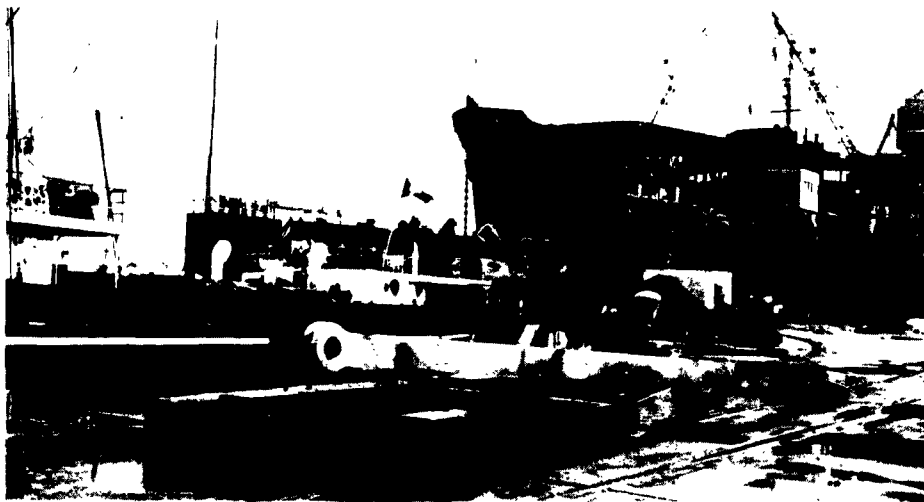


Fig. 70 - Array support hangers on dock at Todd New Orleans prior to installation on Mission Capistrano drydocked in background

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Fig. 71 - View of BB61 windlass looking to port

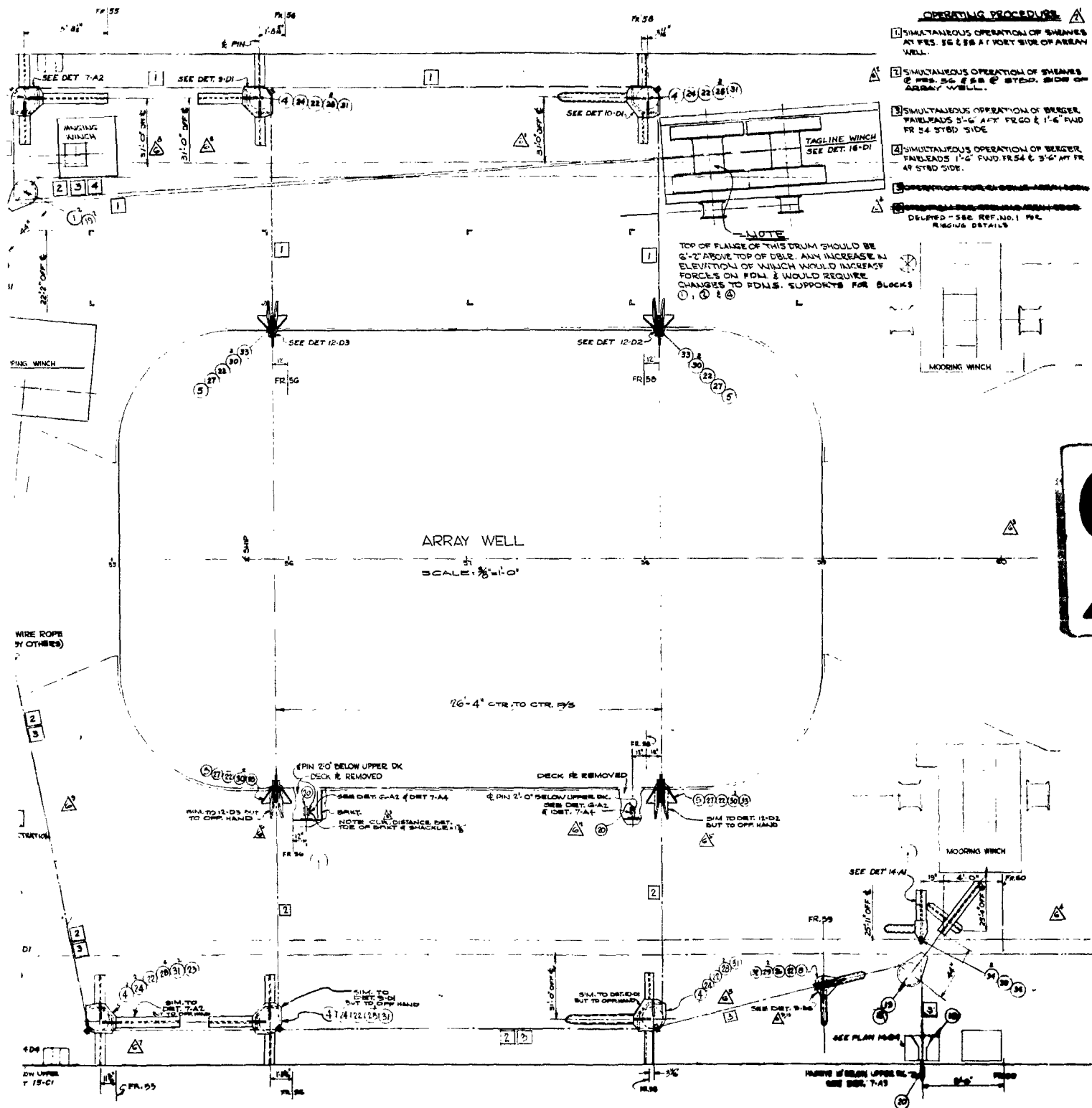


Fig. 72 - Tagline winch arrangement depicting the routes the wire rope will take during final installation of array as fixed source

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A tagline winch is provided on the port side near the well with characteristics as follows:

Manufacturer	Skagit Steel and Iron Works
Type	Model S160, double drum air starting diesel drive
Engine	General Motors Model 6-71 air starting diesel
Capacity	225 hp at 2100 rpm, 60,000 pound line pull, 6000 feet of one-inch wire rope per drum

The tagline winch is located on the port side between frames 58 and 59 (figure 73). This winch serves two purposes. During the operation of the ship and the array and the maintenance of the latter, many large objects will require handling. The winch will serve as a general purpose machine for this need.

At the final installation of the array, the winch will be used to orient the array with respect to the foundation upon which it will be placed. The wire rope will pass over the side of the ship through a sheave placed on an anchor or clump on the ocean floor back through sheaves on the array, through the well and tied off on the deck. The anchors will be placed about 500 feet apart to provide large angles between the wire ropes. By pulling on one line or the other, a force can be applied to the array orienting it in azimuth.

The Western Gear Corporation electric cable winches are designed to pay out or pick up large armored electrical cable efficiently while carrying power without resorting to slip rings and without twisting the cable. The face of each of the main drums is 137 inches wide and is capable of storing in excess of 2,000 feet of electrical cable, 3.03 inches in diameter, in a single layer. They are designed to pick up or pay out cable at an infinitely variable rate between zero and fifteen feet per minute against a maximum cable tension of 30,000 pounds. Each winch is equipped with a ratchet and a pawl which is designed to prevent movement of the drum under static cable loads of 45,000 pounds. A fleeting sheave is provided to level wind the cable onto the drum. Auxiliary equipment, such as limit switches and footage counters are furnished to aid in the operation of the winch (figure 74).

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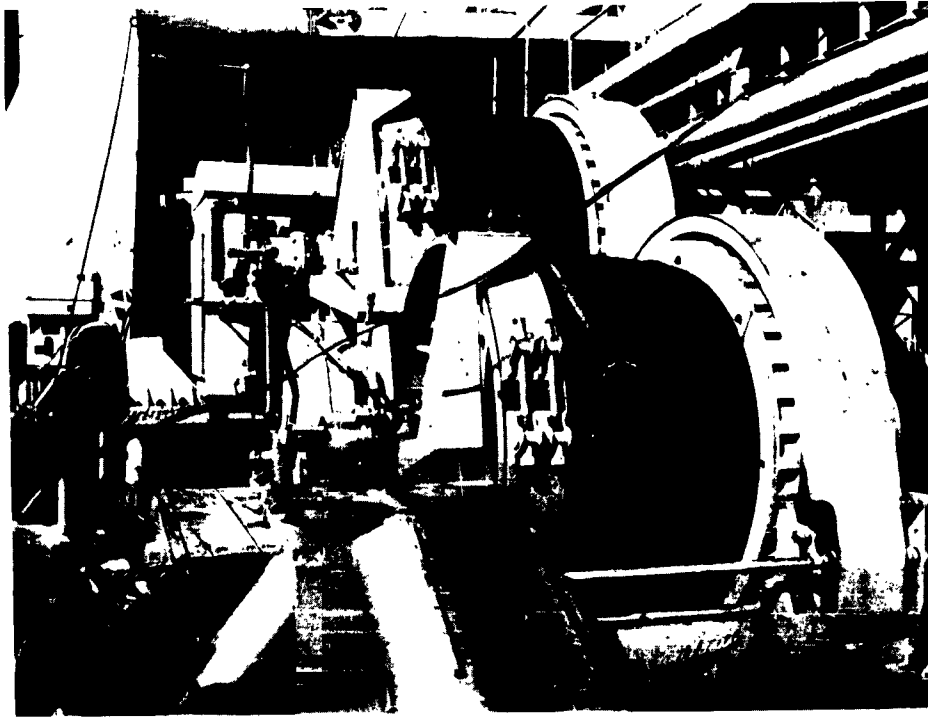


Fig. 73 - Tagline winch

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Fig. 74 - Electric cable handling machine during assembly at Todd New Orleans, Cargo tank No. 3 looking to starboard.

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Each winch is powered by a twenty-five horsepower Electric Products Company Varipak motor.

Each drum is supported by a live stub shaft on the port side and a fixed or dead stub shaft on the starboard side. Extensions of the live and dead stub shafts project into the drum and are connected by means of large universal joints to the auxiliary drum subassembly.

The auxiliary drum subassembly is comprised of two counter-grooved drums, one live and one fixed, whose shafts are jointed by means of connecting arms. The auxiliary drum shafts are also geared together at each end. The fixed auxiliary drum is "secured" to its shaft by means of a large clock-type spring. The live drum is positively secured to its shaft.

The axis of the auxiliary drums are parallel to each other but are skewed to the main drum axis of rotation. One of the auxiliary drums is grooved right hand; the other is grooved left hand.

A ratchet is cut on the port flange of each drum and is engaged by the pawl.

The Tirex or flexible cable enters the hollow fixed shaft, proceeds through the universal into the hollow shaft of the fixed auxiliary drum, through a slot in the shaft to the interior wall of the fixed drum. The Tirex cable, having been clamped to the interior wall of the fixed drum, proceeds via the cable ramp to the exterior of the drum and thence to the live drum. From the surface of the live drum, the cable proceeds into the interior of the live drum and through the slot in the shaft. It then proceeds through the universal, through the live shaft slot, through the cable guard onto the interior wall of the main drum where it is spliced to the main cable. The main cable proceeds from the splice through the cable ramp and is then wound onto the main drum. The cable rises vertically from the main drum, passes over the fleeting sheave and into the cable trunk and thence to the array well or forward over the bow of the ship.

The live auxiliary drum is filled with the Tirex cable when the main drum is filled with double armored cable. During cable pay out, Tirex cable transfers from the live auxiliary drum to the fixed drum and returns to the live drum when cable is picked up by the main drum.

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The auxiliary drum assembly rotates at one-half the speed of the main drum due to the planetary effect of the gearing. The live auxiliary drum rotates about its own axis at the same speed as the main drum and walks around the dead drum, which does not rotate about its own axis. Flexible cable tension is maintained during operation by having the dead drum sprung on its shaft. The counter-grooving of the auxiliary drums is an auto-fleeting device which prevents the flexible cable from fouling during operation.

The fleeting sheave traverses from port to starboard when cable is being payed out. Driving the fleeting sheave is accomplished by rotating the twin acme lead screws from the main reducer through (BSV-102 and BS-104) gear reducers and the final chain sprocket reduction. The sprocket ratio (11T:24T) for the number two and number three winches will spool the cable onto the drum at 3-1/3 inch pitch. The ratio (11T:32T) on the number one winch (for phase I operation) will spool the cable onto the main drum at 2-1/2 inch pitch. For subsequent operation of the number one winch involving larger cables, the thirty-two tooth sprocket should be replaced with the twenty-three sprocket provided.

When cable is being payed out at the maximum rate of fifteen feet per minute, the fleeting sheave traverses at a speed of one inch per minute.

A torque limiter flexible chain coupling on each fleeting sheave assembly serves a dual purpose. The torque limiter springs of the coupling, when properly adjusted, prevent damage to the low horsepower auxiliary drive units in the event of jamming of the fleeting sheave assembly. The other purpose is to provide easy disassembly in order to manually position the fleeting sheave by means of the handwheel.

The trip bar, which is located directly below each main cable drum, actuates limit switches which in turn activate warning devices at the control console, in the event of slack in the cable or overpay of cable on the main drum.

Roller guides are mounted in the well on the port side. These provide an adequate bending radius for the electric cable to prevent any damage from a sharp bend.

A footage counter system consisting of two transmitters per electric cable machine is provided. One counter is located in the cargo tank and operates from a sheave there and the second is mounted in the well. This will indicate the amounts of cable passing each place, thus indicating any malfunction or obstruction in the cable run.

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Tension on the electric cable is measured in the cable machinery room and at the array well. Measurement at the cable machinery is by a watt-meter measuring the power at the winch machinery. Tension at the well is measured by a dynamometer arrangement. These measurements indicate the loads on the cable machinery, thus pointing to any excessive loading due to lack of coordination between the array winch and the cable winch, insufficient catenary in the cable for the water current loads or malfunction of the system.

The winch controls provide infinitely variable speed and automatic tension control. This permits the machinery to "tend" the cable without the necessity of an operator. If the load exceeds the preset value, the winches will pay out cable to reduce the load or, if it is less than the preset value, it will haul in cable. The system is insensitive to small tension changes due to ship motions.

The cable handling machines are located in centerline cargo tanks two and three. The instrumentation cable will be handled by the winch in cargo tank three; the single phase and three phase by those in tank two.

The cable trunk through which the cable passes is just under the deck in the port wing tanks between hold two and the well.

There are two sets of controls, one in the cargo tank and the other on the array control station.

The purpose of the cable handling system is to tend the cable during two phases of the project. Initially, the double armored cable will be handled during the mobile phase.

After the array is installed, the machinery will handle a flexible floating cable which will pass from the bow of the ship to a permanent mooring tower.

A small enclosed platform on the aft end of the midship deckhouse (figures 75, 76) is provided to house the controls for the main array lowering winches and the electric cable handling machinery. Readouts from the aforementioned instrumentation will be located here plus a TV monitoring system so that the operation of all the machinery involved in handling the array can be coordinated. This includes instrumentation as follows:

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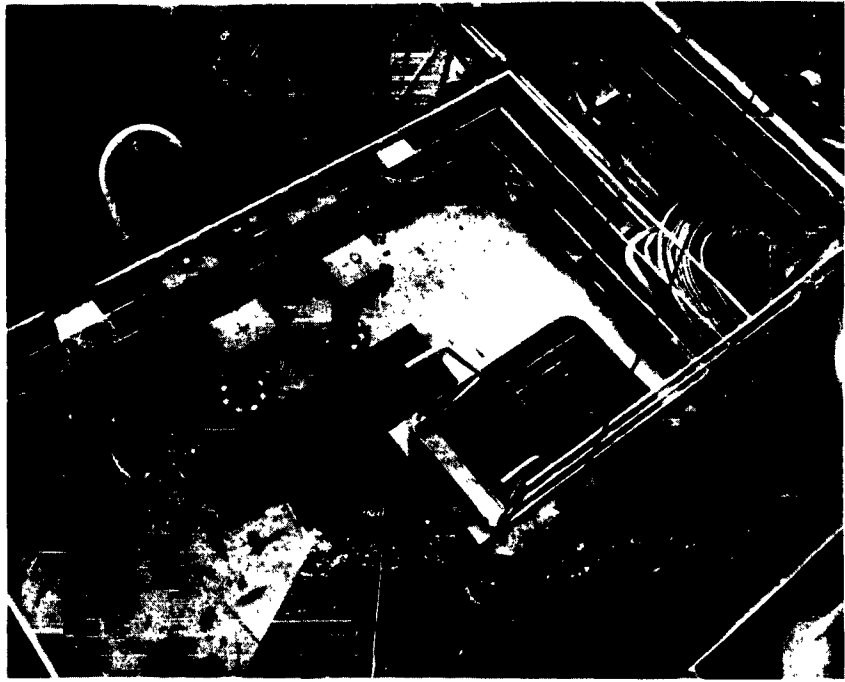


Fig. 75 - Array control station before modification and enclosure.
The controls are for the main array lowering winches.

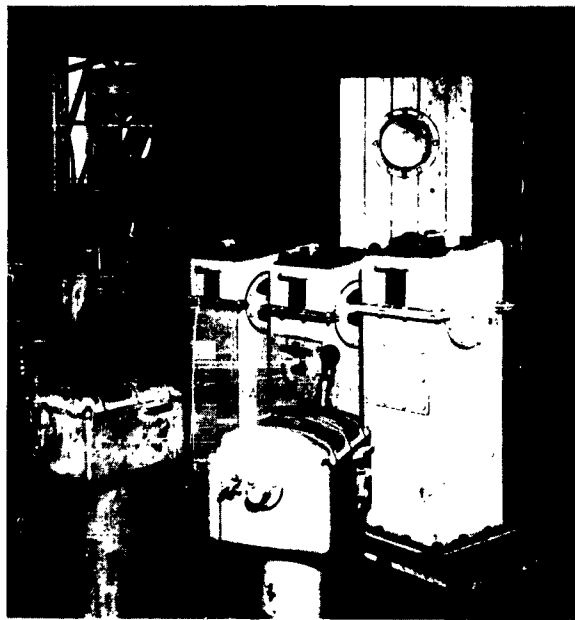


Fig. 76 - Array control system

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8 footage counters

- 1 per cable machine in the machinery room
- 1 per cable machine in the well
- 1 per winch array

1 depth sensor - part of the array instrumentation

2 azimuth indicator - part of the array instrumentation

- Azimuth 360 degrees
- Azimuth ten degrees

1 level indicator - part of the array instrumentation

1 cross level indicator - part of the array instrumentation

4 ammeters for monitoring the current on the main array winch motors

2 voltmeters for monitoring the voltage on the main array winch motors

2 tension indicators on bitter end connection

3 tension indicators on the cable machinery

1 TV monitor system

These various instruments are mounted with appropriate controls where they will be convenient for the operator of the array winch motors, the operator of the electrical cable machines and for the supervisor of this operation. The TV monitor is located overhead with the screen tilted for convenience of the array winch operator and supervisor. All of those instrumentations which are associated with the array instrumentation are duplicated on a relay rack which houses necessary power supplies, calibration signals, etc. This rack is also in the array control station.

As was pointed out in the description of the transducer array, the operation will proceed in two phases; the first the mobile operation and the second the fixed installation. During the mobile phase the operation will consist of lowering and raising the array structure. This will start with the array situated in the well sitting on the hinged supports and secured by the lockout system with the well door closed. When the ship is at location, the well door is opened by means of wire ropes attached to it and running through standpipes to winches on the deck. The lockout system is disconnected. The array is raised several inches by the winches and the hinged supports rotated against the bulkhead. The array is next lowered to any desired depth down to 1200 feet, the electric cable being tended by its machinery. The reverse order is followed for recovery.

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At the final installation, the same sequence will be followed. However, the BB 61 windlasses and the tagline winch will be part of the system at this time.

The 2-1/16 inch chain will be joined to the foundation and pass up through the well and through guides on the array structure. The line will be held taut by the windlass. This provides a guide along which to lower the array.

Any other orienting in azimuth required will be provided by the tagline winch.

This description of the operation of the array indicates the manner in which all the equipment described is coordinated and combined to form a single operating system.

Two diagrams, figures 77 and 78, are included to show the application of the various pieces of deck machinery as well as the basic approach to setting the array structure in place on the bottom.

Figure 77 is a sketch of the installation of the array. In this picture, the array is approximately half-way to the ocean floor. Shown are the eight-point moor, the guide chains, the lowering line and the electric cables being tended by cable handling facility.

Figure 78 shows the same installation after the array has been placed on its foundation. In this sketch the lowering lines and guide chains have been placed on the bottom.

Project Control Center

An area referred to as the project control center has been provided on the deck below the amplifier room. This space provides the equivalent of office space for scientists and technicians associated with the project. Three desks, a large conference-type table, filing cabinets, book shelves and chairs are installed. The layout of this compartment is shown in figure 3 and photographs in figures 79, 80. Figure 79 is looking aft showing the table and file cabinets, whereas figure 80 is looking forward. The latter picture shows the AN/URC-32 transceiver and facsimile receiver as well as desks and other equipment.

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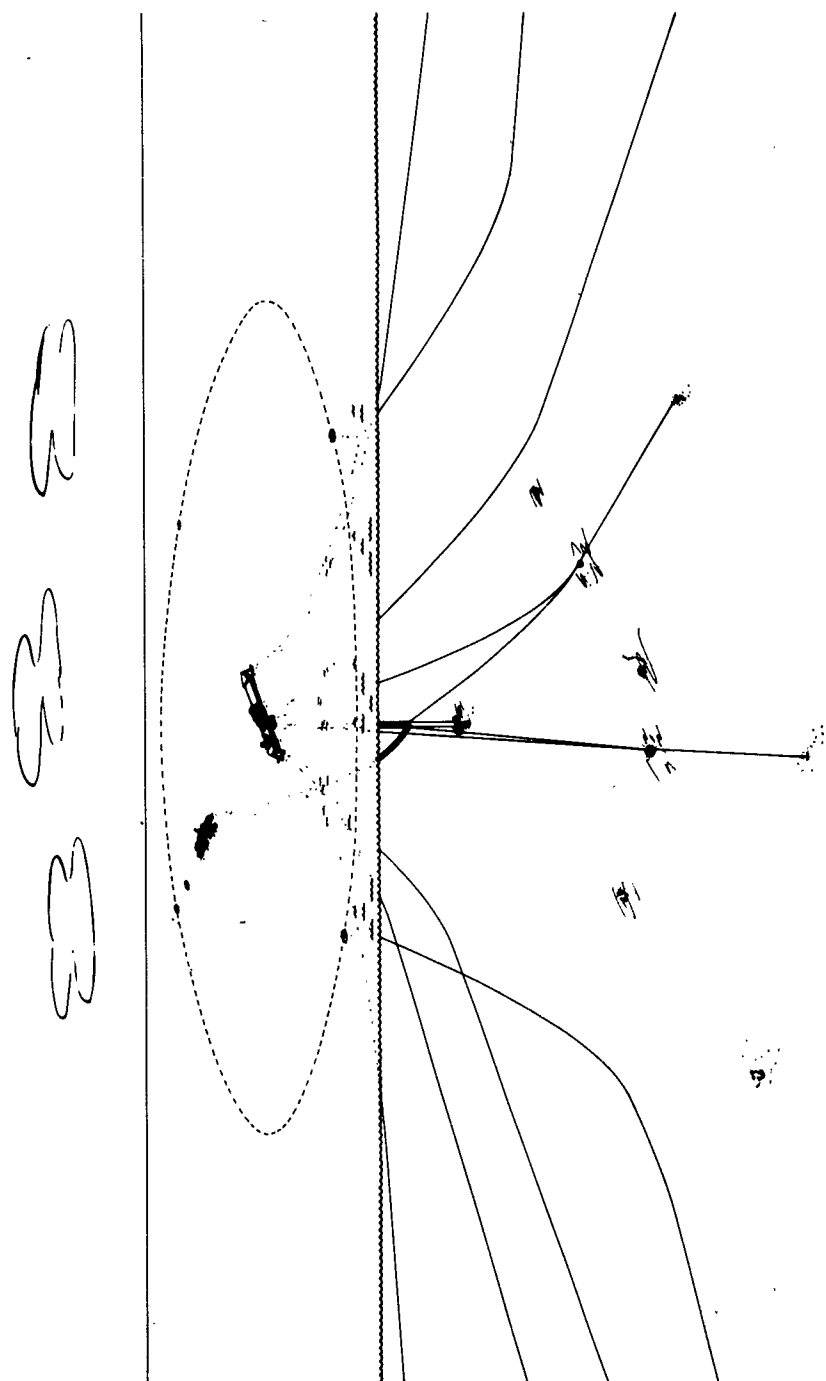


Fig. 77 - Installation of array as a fixed source

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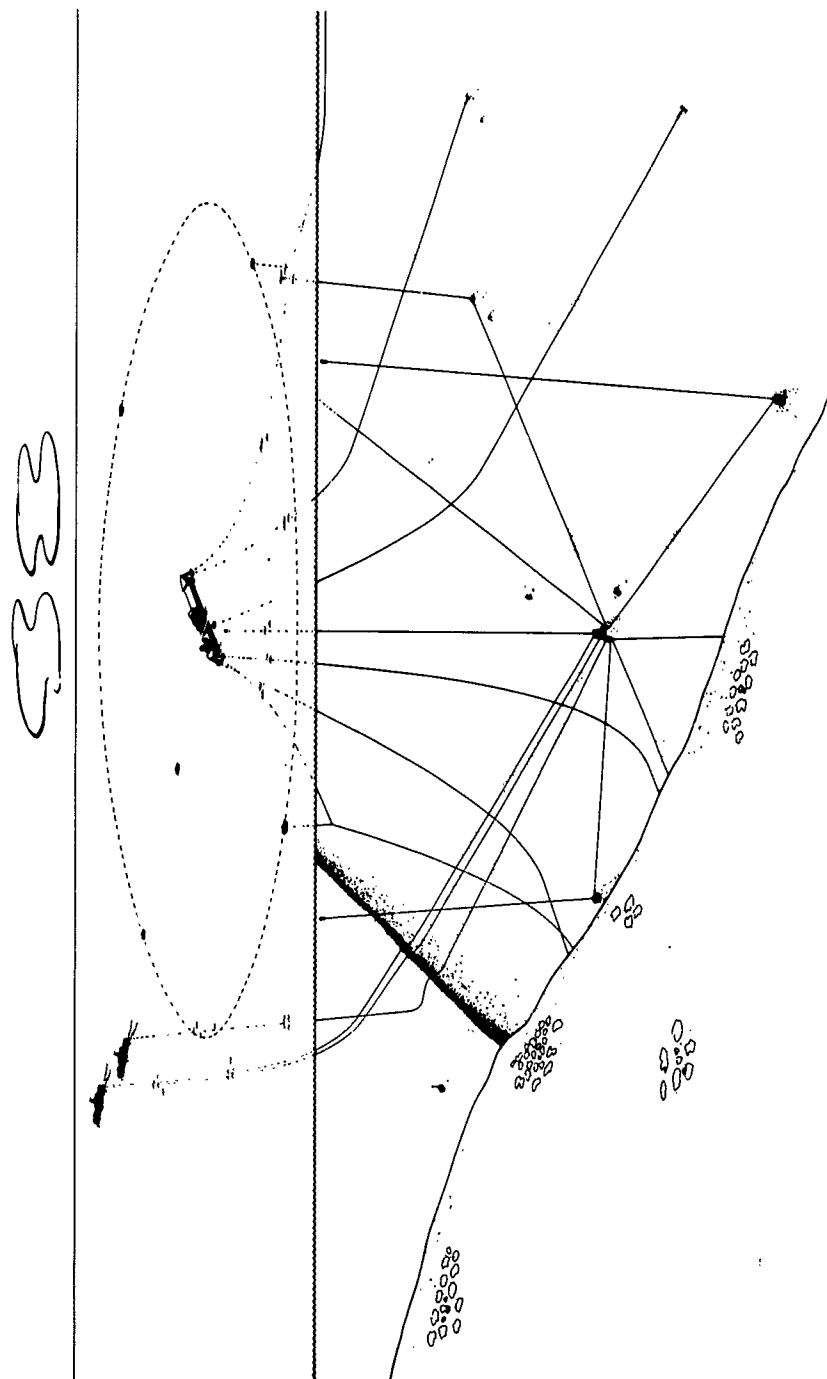


Fig. 78 - Array in place

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Fig. 79 - Project control center



Fig. 80 - Project control center

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DECK MACHINERY

Ship's Anchor Equipment

The ship's anchor windlass is located on the forecastle and is a steam driven double wildcat unit (figure 81). Each wildcat is driven by a separate steam engine. This unit is rated 65.2 horsepower, total, at a steam pressure of 175 psig.

It is capable of hauling in at the following loads and rates:

73,300 pounds	36 feet per minute
15,000 pounds	125 feet per minute

The chain sizes are 2-1/16 inch on the port side and 2-1/2 inch on the starboard side.

The ship is equipped with two Baldt stockless anchors.

Thirty-ton Boom

The thirty-ton boom is a standard cargo hoist located on the starboard side at frame 54 (figure 82).

It is capable of handling thirty long tons at any position of its operating angle. The minimum and maximum topping angles are thirty degrees and seventy degrees, respectively. The boom length is sixty feet and the maximum outreach is fifty-two feet. The horizontal angle through which it can swing is approximately forty-five degrees to starboard through sixty degrees to port (figure 83).

The boom is powered by four winches, as follows:

2 vanging winches

Manufacturer	Sedgewick Machine Works
Type	Single speed de-clutchable
Motor	General Electric 20 hp dc compound wound, 200 rpm

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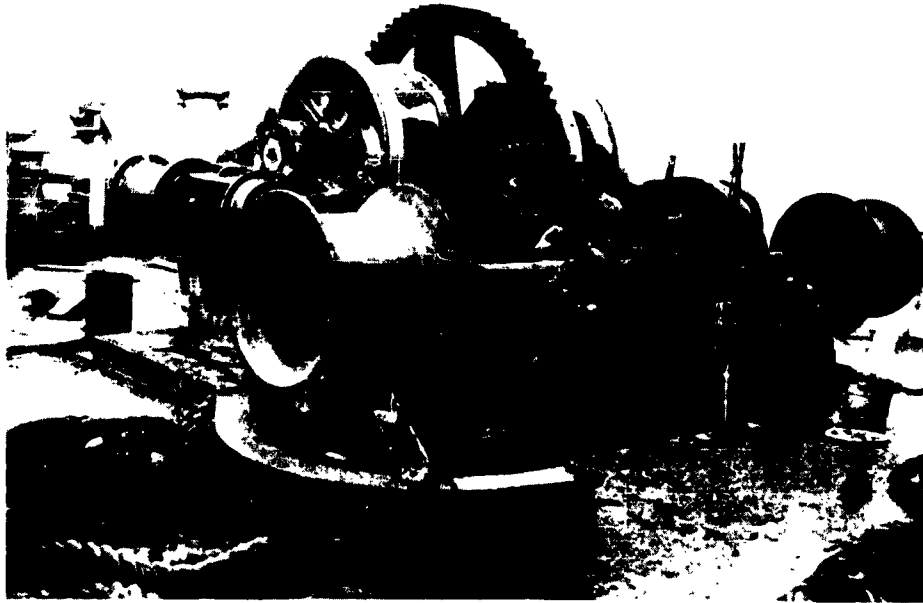


Fig. 81 - Ship's anchor windlass looking to the bow starboard side

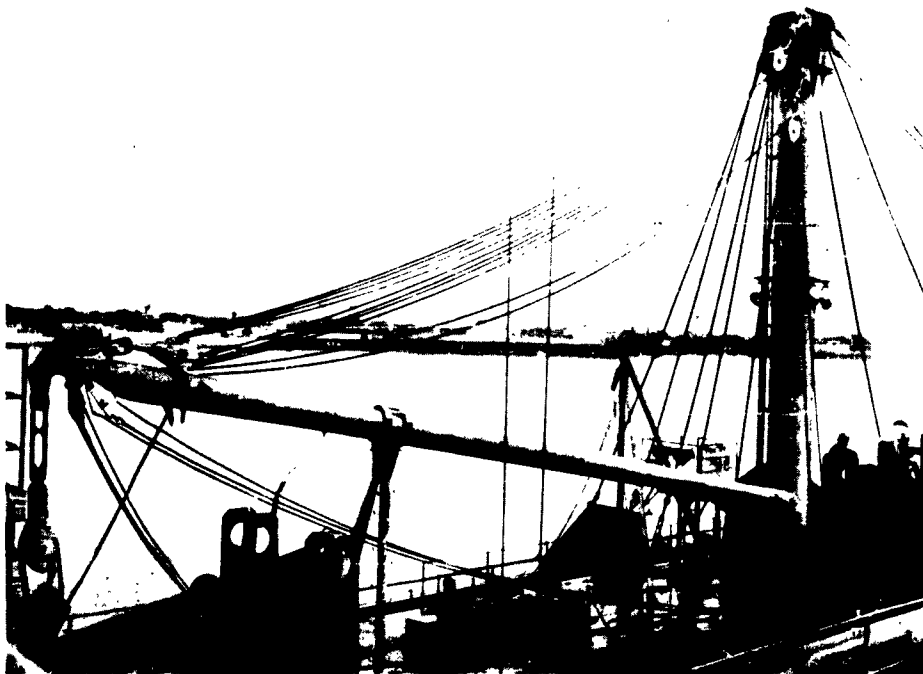
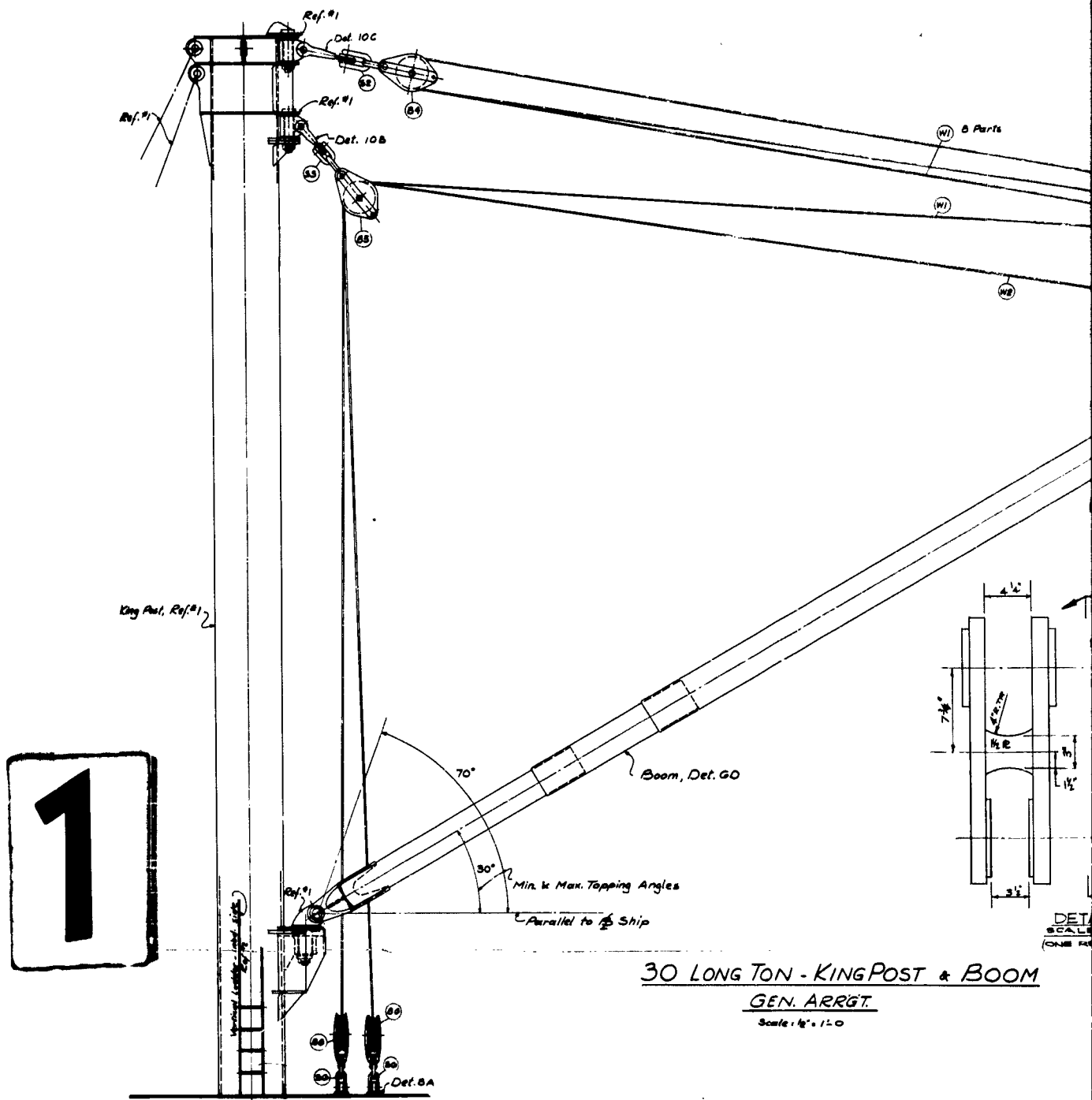


Fig. 82 - Thirty-ton boom looking to starboard



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Fig. 83 - Thirty-long-ton king post and boom

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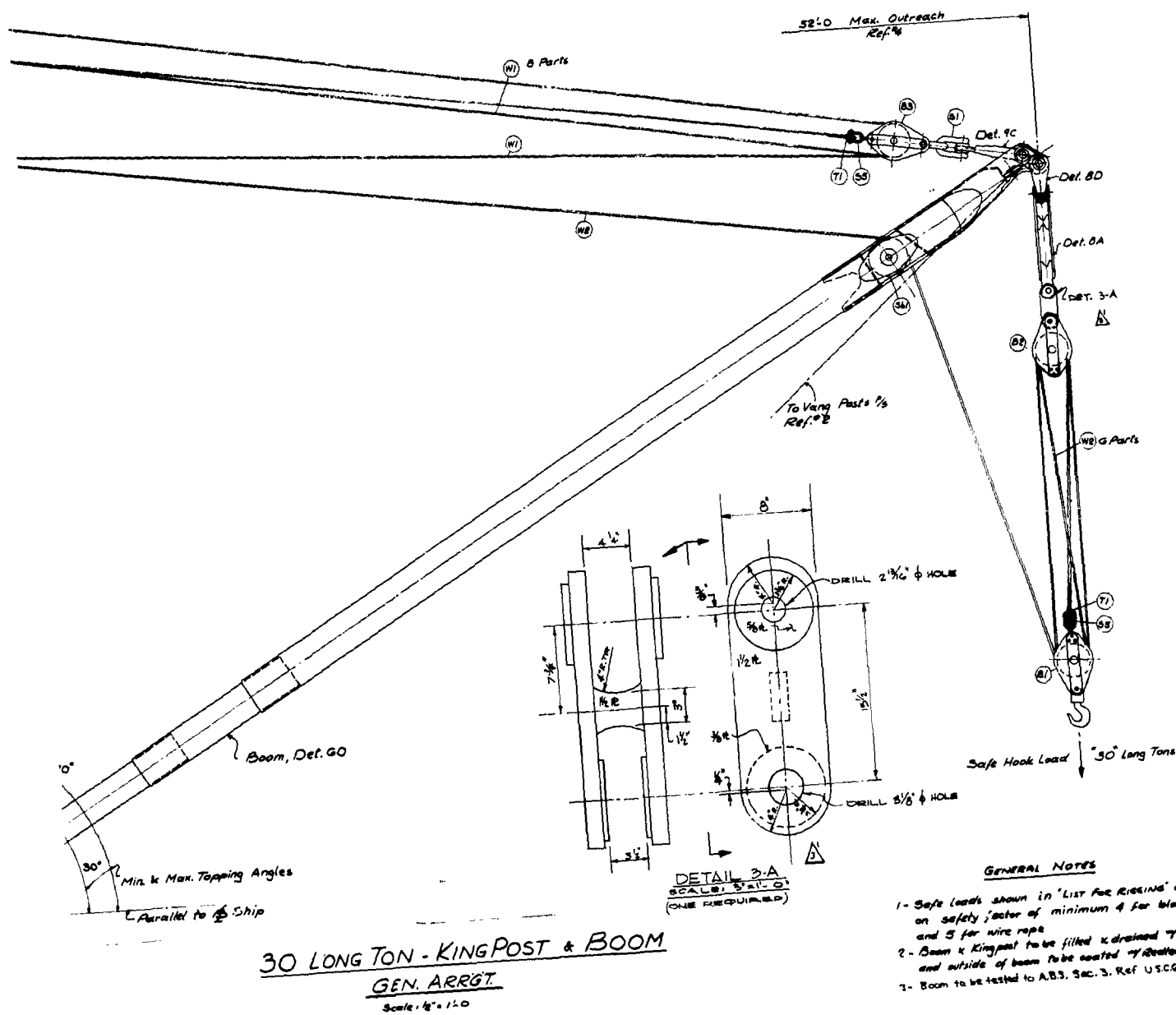


Fig. 83 - Thirty-long-ton king post and boom

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1 Topping winch

Manufacturer

Hyde Windlass Company

Motor

General Electric 50 hp dc shunt wound
525 rpm

1 hoisting winch

Manufacturer

Hyde Windlass Company

Motor

General Electric 50 hp dc shunt wound
525 rpm

The boom will be used for general lifting purposes in handling the modules and other components on the array.

LST Winches

During the installation of the array as a fixed source, it will be necessary to locate the ship accurately over the spot to which the array will be lowered. This will be accomplished with an eight-point moor.

The ship will be positioned in the moor which will have been previously laid. The lines of the moor will be picked up and the LST winches used to tension the lines. These lines will be brought aboard through the Berger fairleads which are near each winch, placed on the winch terminal to about 50,000 pounds and then secured by stoppers (figures 84, 85, 86).

These winches are modified LST stern anchor winches. The modification consists of building up the flanges of the drum to increase the spooling capacity, the removal of the drum grooves and changing the level wind to spool a smaller diameter cable than the winch was originally designed to handle.

The winch as modified has characteristics as follows:

Manufacturer

Almon Johnson Company

Motor

Westinghouse 50 hp 230 volt dc shunt
wound, 525/1800 rpm

Spooling capacity

3000 feet of 1-1/4 inch wire rope

Load capacity

100,000 pounds at 0 to 10 feet/min.
3000 pounds at 400 feet/min.

Drum diameter

approximately 41 inches

[illegible]

Figure 84



GENERAL NOTES

1. RELOCATE SEARCHLIGHT DAWIT AND DESIGN STAFF AT NEW FANSHIRE PLANTS TO SUIT INSTALLATION OF BERGER FAIRLARD ON Q AT BOW.
2. ALTER HANDRAIL AT FRONT OF HANGAR PIPES ON FORECASTLE DECK TO SUIT INSTALLATION OF FAIRLARD AND PIPES AT FRAMES.
3. LOCATIONS OF EXISTING PIPES AND FANSHIRE VENTS ARE TO BE CHECKED AT INSTALLATION AND INSTALLED TO LEAD IN LINE OF PULL. LOCATIONS TO BE SIMILAR P.S. UNLESS OTHERWISE NOTED
4. EXISTING VENTS TO SHIP DECKS, AFT OF FORECASTLE P.S. TO BE LOWERED 2' (WHEN IN POSITION) SECTION OFF 3'-0" OF EXIST. VENT TRUNK, REPLACE TOP SECTION AND WELD.

VERIFY ALL DIMENSIONS IN FIELD PRIOR TO ANY FACILITATION !!

AMW TIME RESPONSE: 1 - 2 HOURS

OMISSIONS OR DIFFICULTIES PERTAINING TO EQUIPMENT AND/OR STRUCTURES NOT INSTALLED BY AMW

[illegible]

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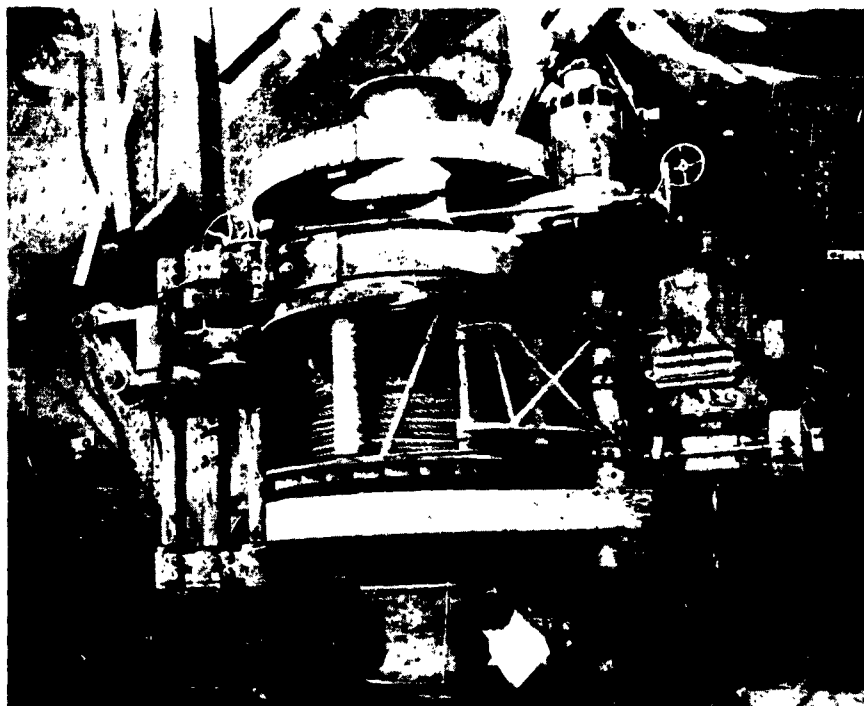


Fig. 85 - LST stern anchor winch



Fig. 86 - LST stern anchor winch. Note Berger
Fairleads at side of ship.

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There are seven stern anchor winches presently installed on the ship, as follows:

- | | |
|--------------|--------------------|
| a. Frame 70 | Starboard and port |
| b. Frame 60 | Starboard and port |
| c. Frame 49 | Starboard and port |
| d. Poop deck | |

Motor Launch

A forty-foot motor launch will be installed aboard the USNS MISSION CAPISTRANO to provide a craft for any testing that must be done in the immediate vicinity of the ship during the mobile phase of operation.

After the array has been installed as a fixed source, the launch will serve to transport men and equipment between the ship and the cable tower for maintenance (figure 87).

The characteristics of the launch are:

- | | |
|-----------------|-----------------------|
| Length overall | 49 feet, 1-1/4 inches |
| Beam (maximum) | 12 feet, 2 inches |
| Engine | HP - 165 |
| Hoisting weight | 17,600 pounds |

The launch will be handled by Cappel pivoted gravity-type davits.

COMMUNICATION EQUIPMENT

Three sound powered telephone circuits are installed. These are of the string type with the telephone jackbox at each station connected in parallel.

Circuit X1J, which is for the project equipment, will have the following stations:

1. Amplifier console
2. Generator control room
3. Project control center
4. Master's stateroom

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5. Pilot house
6. Technicians recreation room
7. Bow
8. Array control station
9. Engine room
10. Chief engineer's stateroom
11. Switch gear platform
12. Cable compartment number one
13. Cable compartment number two

The bow station will be equipped with a headset while all other stations each will have a handset. Call switches and bells are installed at each X1J station as shown in figure 88.

Circuit X2J, which is for amplifier operations, will have the following stations:

1. Amplifier control console
2. Amplifier number one control cubicle
3. Amplifier number two control cubicle
4. Amplifier number three control cubicle
5. Amplifier number four control cubicle

The circuit for the station at the amplifier control console will be connected through a selector switch (X1J and X2J) to a common jackbox and headset. Additional jacks for the X2J circuit will be available at each amplifier cubicle. The console station is illustrated in figure 89.

A third phone circuit is installed for operation of the array handling equipment. This is a parallel system with no call bells. Stations are installed at the following positions:

1. One at each of seven LST winches
2. Array control station
3. Pilot house
4. Anchor windlass
5. One at each of two BB 61 winches
6. Tagline winch

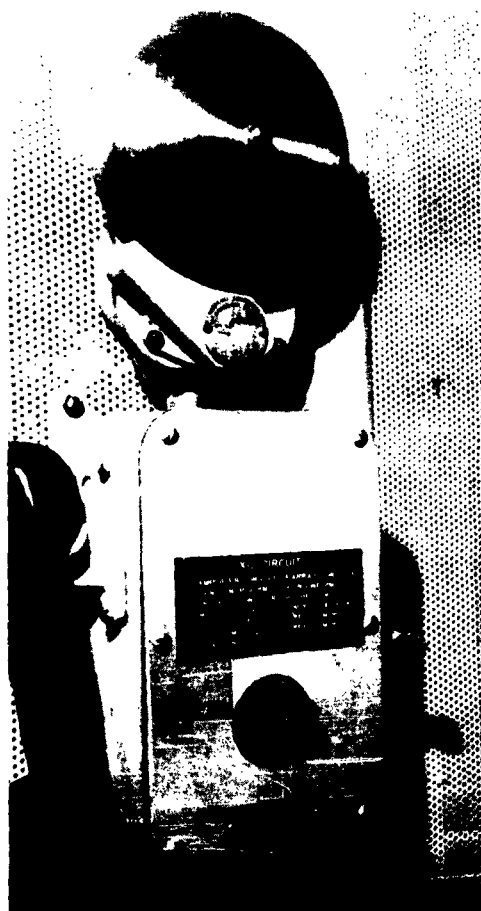
In addition to the permanently installed phone system, four portable carrier current intercommunication stations are available.

In order to meet any special requirements for communication on an interim basis, two sets of sound powered phones are also available. One of these will be provided with 100 feet of cable and the other with 200 feet of cable.

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Fig. 87 - Forty-foot motor launch



**Fig. 88 - Sound powered
telephone station**

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Fig. 89 - Telephone station at amplifier control console

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Radio

Voice Communication

One AN/URC-32 transceiver is installed in the project control center. (first platform between frames 59 and 65) This is shown in figure 90. The unit will provide voice communication with the assist ship and various shore stations, including the U. S. Naval Research Laboratory. Operation may be from the project control center or from a remote control station located at the amplifier control console in the amplifier compartment.

The AN/URC-32 is a single sideband transceiver covering the band 3.4 to thirty-two megacycles in one kilocycle per second steps. The transmitter has a peak effective power of 500 watts. In this installation, the antenna is a thirty-five foot whip located on the bridge deck.

Data Link

A frequency shift keyer and transmitter located in the amplifier compartment adjacent to the amplifier control console will provide a data link between the source station and the monitor ship. Its use is described in the "Instrumentation Monitoring and Control" section under the "Acoustic Monitoring and Calibration" heading. The operating frequency is 5.345 megacycles. A pre-pulse signal from the master programmer will cause the carrier frequency to shift by four kilocycles per second. The key pulse, which is coincident with the beginning of the source transmission, will cause the frequency to shift back to its nominal value. The radiated power is approximately eighty-five watts.

Facsimile

A model RD-92/UX facsimile equipment is also located in the project control center. This will be used to receive weather maps. A view of the facsimile equipment is shown in figure 91.

NAVIGATION EQUIPMENT

The ship's navigation equipment consists of a radio direction finder, two radar sets and a fathometer. These equipments have characteristics as described below.

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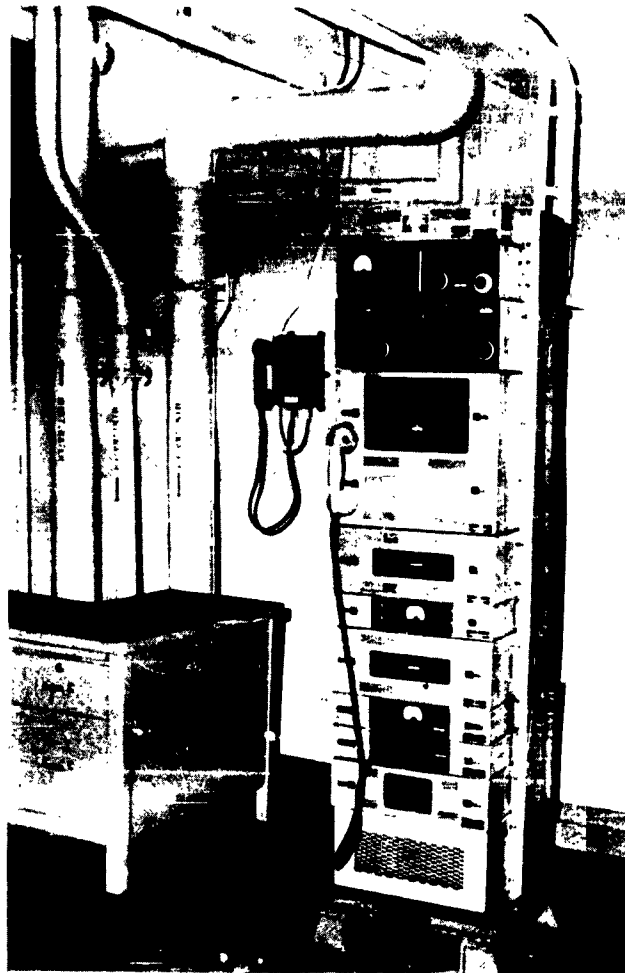


Fig. 90 - Shipboard installation
of AN/URC-32 transceiver

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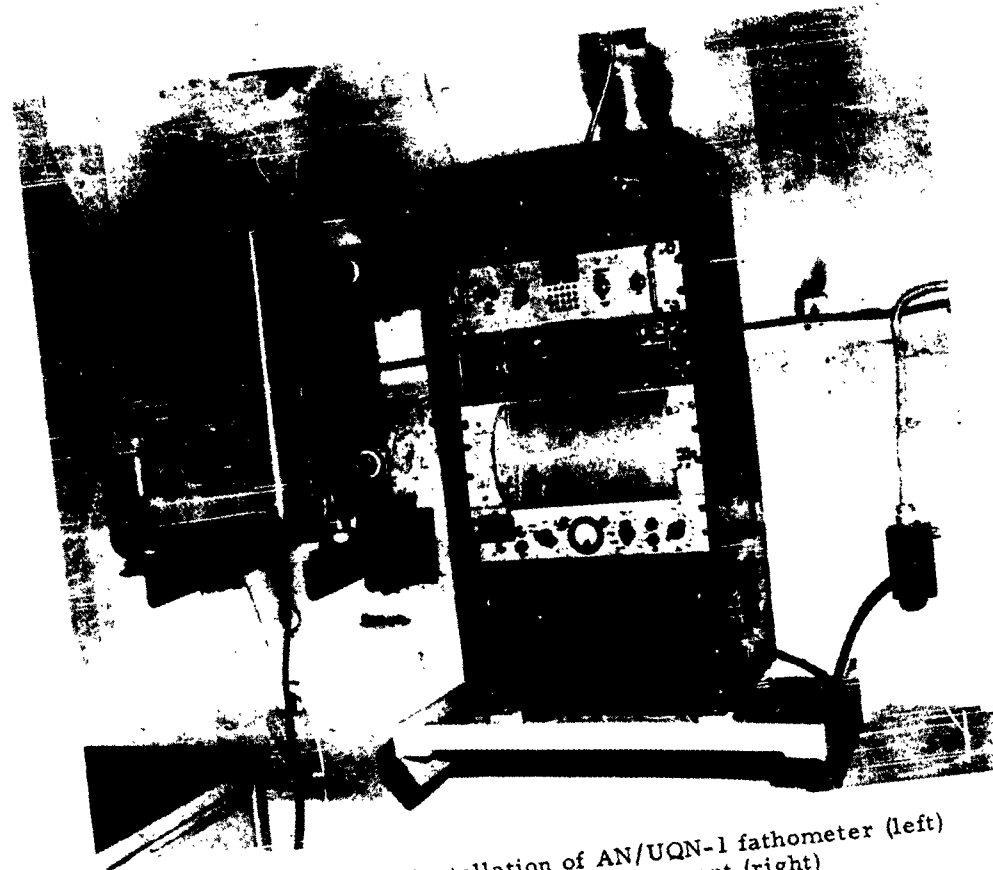


Fig. 91 - Shipboard installation of AN/UQN-1 fathometer (left)
and RD-92/UX facsimile equipment (right)

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Radio Direction Finder

Marine radio direction finder type 4004-A, manufactured by Mackay Radio and Telegraph Company, Incorporated, is located on the starboard side over the navigation chart table in the chart room and is designed to function effectively in the presence of heavy static and interference.

This unit consists of a fixed loop and a compact receiver-indicator. It operates from the ship's 115 volt ac supply and requires forty watts of power. The receiver is of a superheterodyne type, at a frequency range of 200-525 kilocycles, and has a sensitivity of approximately one micro-volt.

The indicator permits true bearing to be read on an indirectly illuminated, luminescent dial. Received signals may be monitored also by use of headsets or a built-in speaker.

Mariner's Pathfinder Radar Model 1400

The Mariner's Pathfinder radar is composed of three main assemblies:

- Indicator unit 1525A
- Transmitter-receiver unit 1526A
- Antenna assembly CX-1275/A (12 feet)

The indicator unit is of the console type and is located in the wheelhouse. A large scale presentation is provided via a sixteen-inch cathode ray tube with ppi type of indicator. There are six range scales: 1, 2, 4, 8, 20 and 40 miles. The ratio of adjacent scales is 2-1, thereby permitting a good choice of areas to be scanned.

The transmitter-receiver unit is located in the charthouse aft and is composed of the following units:

- Transmitter
- Modulator
- Power supply
- Receiver
- Echo box
- Blower assembly

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Trigger (pulsing) power for the transmitter is produced by a hydrogen thyratron tube. A short pulse of 0.14 microseconds is used for the 1, 2 and 4 mile ranges to provide improved short range definition, while a longer pulse of 0.60 microseconds is used on the longer ranges. A magnetron-type oscillator tube converts the pulsed power into microwave energy which is carried to the antenna via a waveguide system.

The receiver is of a superheterodyne type using a crystal mixer, and utilizes an FTC (fast time constant) circuit in the video amplifier. This circuit aids in the separation of small objects and is especially useful in spotting rain squalls and channel buoys.

The antenna is designed for operation in the S-band and is located on the foremast. This is composed of a twelve-foot reflector, waveguide nozzle, rotating mechanism and mounting pedestal. The antenna assembly is designed to operate in the S-band. Special attention was given in the antenna design to minimize the minor side and back radiated lobes, thereby reducing the intensity of ghost images.

The Mariners Pathfinder radar model 1400 operates in the S-band and is capable of a maximum range of forty miles and a minimum range of approximately thirty-five yards.

Mariners Pathfinder Radar Model 1500

The Mariners Pathfinder radar model 1500 is composed of two major units; that is, the antenna and indicator. The antenna unit contains the transmitter, duplexer and receiver amplifier. The indicator unit contains four items; namely, the indicator, modulator, receiver and rectifier power supply.

Special provisions have been made in this unit to reduce interference; thus, calibration and operation of the radar will not cause serious interference to the communication equipment aboard the ship. Adequate filtering and shielding have been employed against radiation and conducted noise to meet FCC standards.

The antenna unit produces a beam pattern having a horizontal width of two degrees and a vertical width of fifteen degrees. This assembly is driven by a one-sixth horsepower ac motor and is capable of operating in any wind up to seventy-five knots.

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The transmitter output peak power is seven kilowatts at a repetition rate of 1500 cycles per second. Pulse length is 0.2 microseconds. The oscillator is a magnetron type with a local oscillator of a remote control klystron.

Presentation is on a ten-inch ppi tube with a reflection plotter an integral part of this unit. The range scales employed are one, two, four, eight and sixteen miles with range marks at one-half, one, two and four mile intervals. The accuracy of this system is ± 2.5 percent. The reflection plotter on the ppi provides a method to obtain relative and true motion plots at all times.

The antenna is located on the foremast below the model 1400 radar antenna with a receiver indicator and plotter on the port side of the wheelhouse of the navigation bridge.

Sonar Sounding Set AN/UQN-1E

Sonar sounding set AN/UQN-1E is an echo ranging equipment which is used to measure water depth and either to record it permanently on a paper chart or visually on the face of a cathode ray tube. It is composed of two assemblies; a sonar receiver-transmitter, RT-166()/UQN-1 and a sonar transducer, AT-200()/UQN-1.

The transmitter produces an icw tone which is crystal controlled on the frequency of twelve kilocycles. The transmitter is capable of a peak output of 800 watts into the transducer load of 200 ohms. Selection of either a single ping or automatic keying operation is available.

Operating on the superheterodyne principle, the receiver resolves the twelve kilocycle signal to 4000 cycles of the power level of one-half watt minimum into a 5000 ohm load.

Permanent presentation is obtained by means of a chart recorder that is calibrated for three ranges; i.e., 0-600 feet, 0-600 fathoms and 0-6000 fathoms. A visual means of indication is provided on a cathode ray tube and permits the operator to view one of two ranges; 0-100 feet and 0-1000 fathoms. Provision is made for audible monitoring via speaker or headsets.

Sonar transducer, AT-200()/UQN-1 comprises an array of ammonium dihydrogen phosphate crystals in a pressure-tight, flanged housing that is designed for flush mounting in a standard hull ring in the bottom plating of a surface vessel. Total weight of the AN/UQN-1E is 381 pounds.

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ELECTRONICS WORKSHOP

The electronics workshop is located on the port side between frames 63 and 65 (figures 92, 93). The shop has 420 square feet of floor space and contains the following equipment.

- 1 grinder, electric, 1/2 hp, 115 volt ac, single phase, 60 cycle, bench-type, with two grinding wheels 7 inches diameter x 1 inch wide, mounted on each end of a direct motor-driven spindle
- 1 drill press, 16 inches, electric, 1/2 hp, 440 volts ac, 3 phase, 60 cycle, bench-type, with 3-inch diameter steel column and base, motor driven
- 1 lathe, engine, precision, cabinet type, 10' x 18' centers, motor driven, attachments, mechanical variable speed drive, with attachments
- 1 vise, machinists, 6 inch with swivel base and stationary jaw
- 1 vise, machinists, 3 inch with stationary base and jaw
- 1 vise, combination, 4-1/2 inch, with bench clamp
- 2 tool lockers, metal, 12 inches wide by 3 feet long by 3 feet high
- 2 workbenches, metal, 30 inches wide by 10 feet long by 3 feet 2-1/2 inches high
- 1 workbench, electronics, metal, 34 inches wide by 20 feet long by 3 feet 1-1/2 inches high

There is a five-foot by five-foot hatchway which provides access to the amplifier room which is one deck above. There are doors providing access to the project control center and the electronics storeroom. The only exit to the main deck is through the project control center and up an escape hatch directly to the main deck.

STOWAGE FACILITIES

The USNS MISSION CAPISTRANO has a total of 4630 square feet of dry stowage area.

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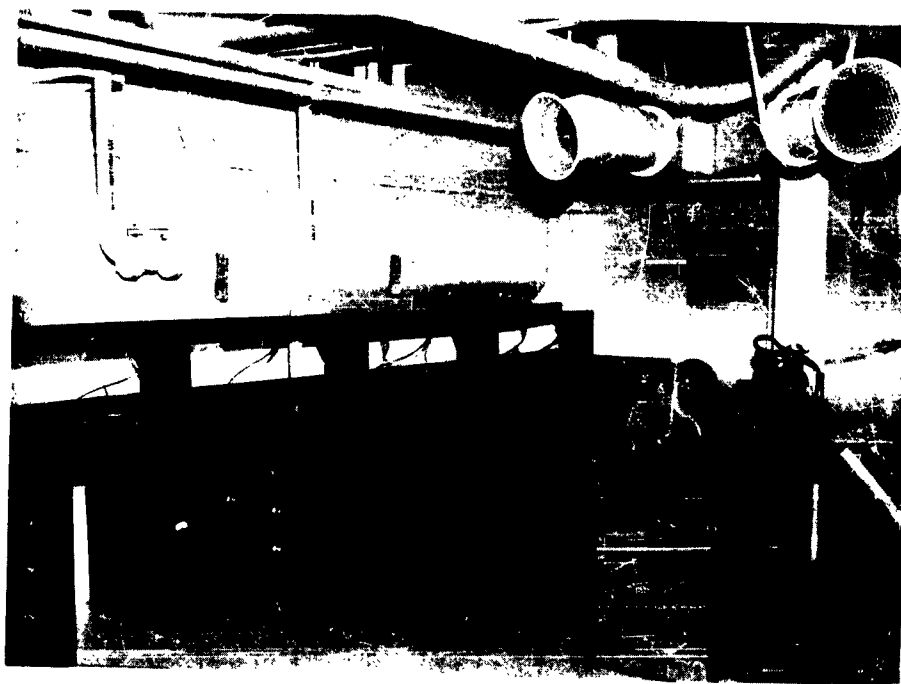


Fig. 92 - Electronic work shop

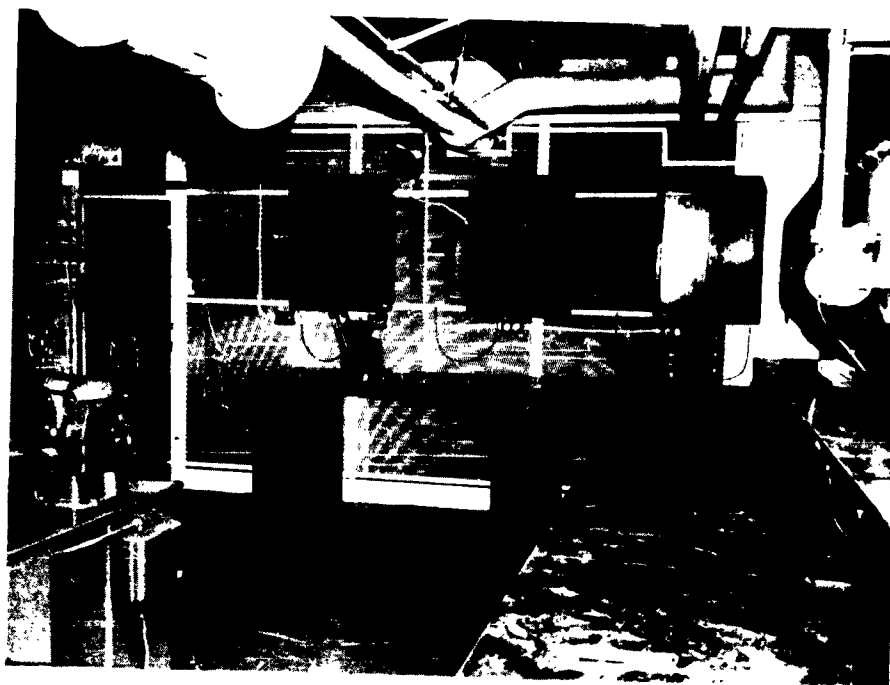


Fig. 93 - Electronic work shop

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This is to be used as follows:

STOWAGE

<u>Stores</u>	<u>Frames</u>	<u>Deck</u>	<u>Floor area Sq. ft. (approx.)</u>
Electrical	20-28 port	Upper	800
Bulk	62 port	Main	30
Engineers	5-19	Second	1000
Cement and mud	75-89	Second	1200
(to be used during installation of array)	60-62	1st platform	400
	89-97	1st platform	400
Electronics	62-63	1st platform	200
Boatswain	89-Fwd.	Second	600
			<u>4630</u>

Figure 94 illustrates the storage area arrangement for electronics parts adjacent to the electronics work shop.

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Fig. 94 - Electronic store room

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APPENDIX I
UNIT IDENTIFICATION NUMBERS
FOR PROJECT EQUIPMENT

<u>Description</u>	<u>Unit Number</u>
Support Structure, Array	1
Electrical Junction Box	2
Component Tank Assembly (4)	3-6
Unassigned	7
Hydrophone Assembly-Position Sensing	8
Unassigned	9-18
Instrumentation Capsule	19
Unassigned	20
Underwater TV Control Unit	21
Unassigned	22
Junction Box Instrumentation	23
Unassigned	24
Foundation Platform	25
Gas Turbine Assembly	26
Generator Assembly	27
Lube Oil Reservoir	28
Lube Oil Pump	29
Control Cubicle, Starting Motor	30
Lube Oil Console	31
Fuel Oil Console	32
Turbine Control Panel	33
Regulator Control Panel	34
Amplidyne Motor Generator	35
Hydraulic Power Pack	36

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Power Amplifier (4)	37-40
Amplifier Control Console Assembly	41
Motor Control Center	42
4160 Volt Switchgear	43
3500 Volt Switchgear	44
480 Volt Switchgear	45
2000 KVA Transformer	46
500 KVA Transformer	47
AC Panelboard, 480 Volt	48
DC Panelboard, 125 Volt	49
Instrumentation Control Center, 480 Volt	50
4160 Volt Selector Switch (4)	51-54
15,000 Volt Selector Switch (8)	55-62
Load Matching Transformer	63
System Test Load	64
Single Ampere Test Load	65
Reservoir, Distilled Water	66
Heat Exchanger	67
Pump, 10 hp	68
Pump, 25 hp	69
Tower	70
Sensor Sampling System	71
Position Determination System Rack I	72
Position Determination System Rack 2	73
Control Station Instrumentation	74
Accumulator Single Phase Power Cable Junction Box (Bulkhead)	75
Accumulator Cable Instrumentation Junction Box (Bulkhead)	76

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Unassigned	77
Installation Instrumentation Junction Box	78
Instrumentation Signal Junction Box	79
Instrumentation Signal Junction Box	80
Rack Output Metering	81
Vacuum Relay Assembly	82
Unassigned	83
Master Programmer (2)	84-85
Receiver Preamplifier	86
Transmitter/Receiver (AN/URC-32)	87
Accumulator 3 Phase Power Cable Junction Box (Bulkhead)	88
Motor Starter, 2 hp	89
Motor Starter, 2 hp	90
Array Winch Control	91
TV Monitor Unit	92
Interim Power Junction Box (Massa)	93
Interim Instrumentation Connector Plate (Simplex)	94
Instrumentation Cable Termination (Array)	95
3 Phase Power Cable Termination (Array) (Simplex)	96
Single Phase Power Cable Termination (Array)(Simplex)	97
Pressure Sensor Capsule	98
Instrumentation Interconnecting Cable, 27 Conductor	99
Instrumentation Interconnecting Cable, 27 Conductor	100

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Unassigned	77
Installation Instrumentation Junction Box	78
Instrumentation Signal Junction Box	79
Instrumentation Signal Junction Box	80
Rack Output Metering	81
Vacuum Relay Assembly	82
Unassigned	83
Master Programmer (2)	84-85
Receiver Preamplifier	86
Transmitter/Receiver (AN/URC-32)	87
Accumulator 3 Phase Power Cable Junction Box (Bulkhead)	88
Motor Starter, 2 hp	89
Motor Starter, 2 hp	90
Array Winch Control	91
TV Monitor Unit	92
Interim Power Junction Box (Massa)	93
Interim Instrumentation Connector Plate (Simplex)	94
Instrumentation Cable Termination (Array)	95
3 Phase Power Cable Termination (Array) (Simplex)	96
Single Phase Power Cable Termination (Array)(Simplex)	97
Pressure Sensor Capsule	98
Instrumentation Interconnecting Cable, 27 Conductor	99
Instrumentation Interconnecting Cable, 27 Conductor	100

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Instrumentation Interconnecting Cable, 8 Conductor, 50 Feet	101
Instrumentation Interconnecting Cable 8 Conductor, 100 Feet	102
Kirk Interlock Assembly (2)	103-104
Transducer Module (20)	105-124
Underwater TV Camera (6)	125-130
Underwater Lights (12)	131-142
Armor Clamp Installation Instrumentation Cable	143
Unassigned	144
Inlet Silencer (2)	145-146
Butane Storage Bottle (3)	147-149
Submarine Single Phase Power Cable	150
Pressure Sensor Capsule	151
Single Phase Power Cable Termination (Tower)	152
Submarine 3 Phase Power Cable	153
Strain Relief Bell, Single Phase Power Cable	154
3 Phase Power Cable Termination (Tower)	155
Submarine Instrumentation Cable	156
Strain Relief Bell, 3 Phase Power Cable	157
Instrumentation Cable Termination (Tower)	158
M.I. Single Phase Cable	159
Interim Single Phase Adaptor Plate	160
Submarine Single Phase Power Cable Armor Clamp (Tower)	161
M.I. 3 Phase Cable	162
Interim 3 Phase Adaptor Plate	163
Submarine 3 Phase Power Cable Armor Clamp (Tower)	164

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M.I. Instrumentation Cable	165
Strain Relief Bell Instrument Cable	166
Submarine Instrumentation Cable Armor Clamp (Tower)	167
Strain Relief Bell Installation Instrumenta- tion Cable	168
Breakaway Armor Clamp M.I. Single Phase Power Cable	169
Breakaway Armor Clamp M.I. 3 Phase Power Cable	170
Breakaway Armor Clamp M.I. Instru- mentation Cable	171
Gas Supply System	172
Gas Tank, Nitrogen (10)	173-182
1/2 Control Valves 3000 psi	183
3/4 Control Valves 3000 psi	184
3/4 Relief Valves 3000 psi, Disc Type	185
Shock Absorbers	186
Tower Terminal Housing	187
Installation Instrumentation Cable	188
Hydrophone Splice Box	189
Accumulator Single Phase Power Cable	190
Accumulator 3 Phase Power Cable	191
Accumulator Instrumentation Cable	192
Modified Splice Box Unit Number 199	193
Modified Splice Box Unit Number 200	194
Modified Splice Box Unit Number 201	195
Flexible Single Phase Power Cable	196
Flexible 3 Phase Power Cable	197
Flexible Instrumentation Cable	198
Single Phase Power Cable Drum Junction Box	199

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Instrument Cable Drum Junction Box	200
3 Phase Power Cable Drum Junction Box	201
Instrumentation Interconnecting Cable, 8 Conductor, 100 Feet	202
Instrumentation Interconnecting Cable, 8 Conductor, 100 Feet	203

The project equipment identified above and throughout this report has been supplied under the Office of Naval Research contract with Columbia University, contract Nonr 266(66), by the Bureau of Ships and by the U. S. Naval Research Laboratory. Commercial suppliers of major systems and components are as follows:

Columbia University subcontract

Bendix-Pacific Division, Bendix Corporation

Simplex Wire and Cable Company
General Electric Company
J. Ray McDermott Company, Incorporated
Ling Electronics Division, Ling-Altec Electronics, Inc.
Clark Bros. Co., Division of Dresser Operations, Inc.
I. T. E. Circuit Breaker Company
Sperry Gyroscope Company
Continental Electronics Manufacturing Company

Massa Division, Cohu Electronics, Incorporated

Bureau of Ships

Avondale Marine Ways, Incorporated
Todd Shipyard
Western Gear Corporation
Electric Products Company

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Supreme Electric Company
La Tourneau
J. Ray McDermott Company, Incorporated
Simplex Wire and Cable Company
General Electric Company

The above list is not intended to be all-inclusive, but to cover only major components.